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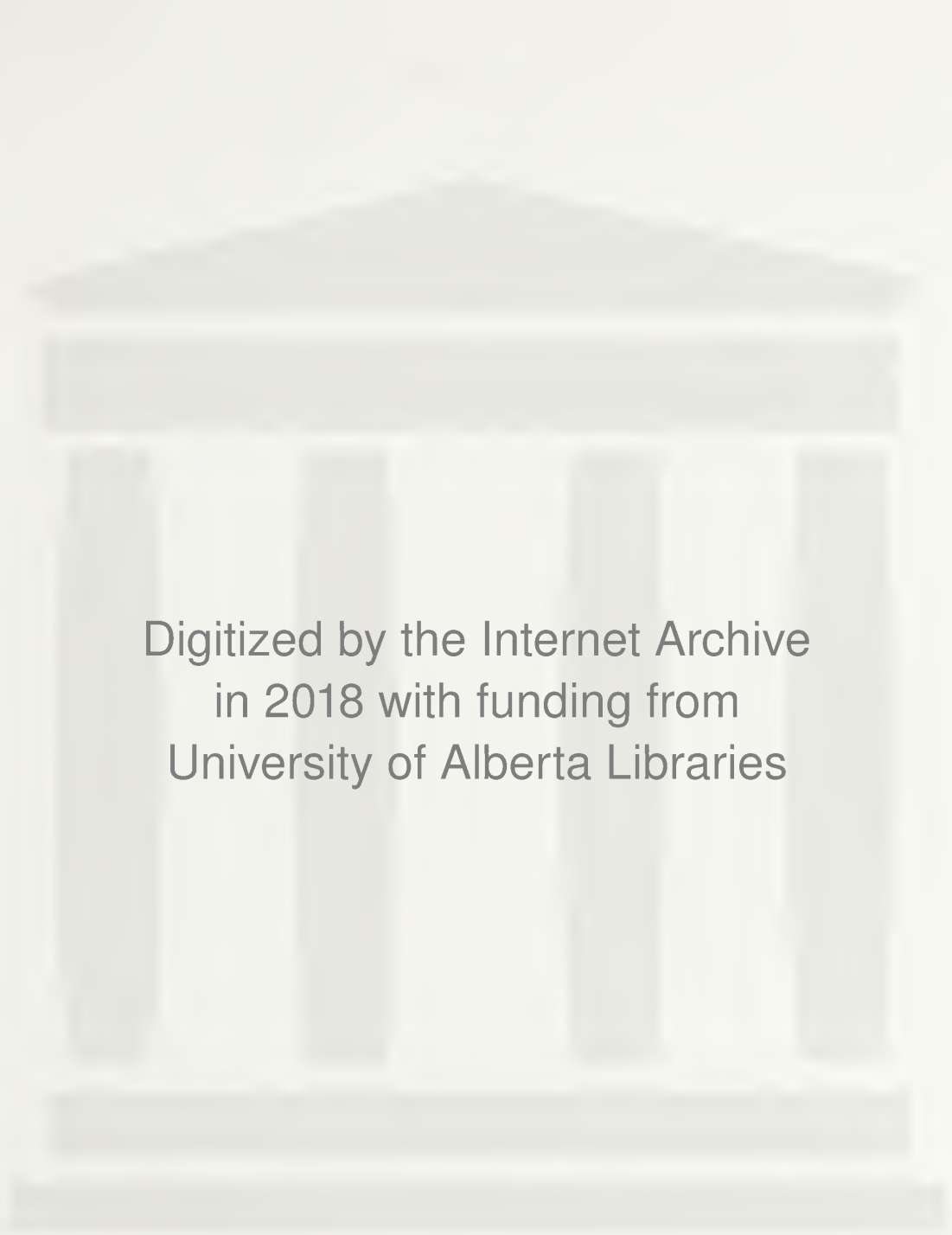
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ANALYSIS OF SPEED AND ACCURACY ON TIMED WRITINGS

by

Philip Uniat

A THESIS

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ABSTRACT

The purpose of the study was to determine the gross speed pattern and the accuracy pattern of typewriting students on five-minute straight-copy writings. The speed pattern was obtained by examining the gross speed rates at one-minute intervals of the timed writings. Similarly, the accuracy pattern was obtained by examining the number of errors made in each one-minute interval of the timed writings.

The subjects in the study were Typewriting 10 students enrolled in Fort Saskatchewan High School in 1963-64. Students were given four five-minute straight-copy writings. Intervals of one-minute duration were marked on paper by an electrical device attached to each typewriter. The gross speed and errors were calculated for each interval of the timed writings.

The analysis of variance was the technique used to test the following hypotheses: (1) There is no significant difference in the mean typewriting speed achieved by students of Typewriting 10 in the one-minute intervals of a straight-copy five-minute test, and (2) There is no significant difference in the mean errors typed by students in the one-minute intervals of a straight-copy timed test.

It was found that the highest gross speed occurred in the first one-minute interval of the timed writings. There was a pronounced decrease in speed in the second interval, after which, speed increased in the third, fourth, and fifth intervals of the timed

writings. The error rates in the first three one-minute intervals remained fairly constant, but increased to significant levels in the fourth and fifth intervals of the writings.

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CHAPTER I

INTRODUCTION

NEED FOR THE STUDY

When straight-copy timed tests are administered in typewriting, the gross speed is obtained by dividing the number of words typed by the number of minutes of the timed writing. The average number of errors is obtained in a similar way. Unfortunately, significant information is overlooked when typewriting performance is expressed in terms of gross speed and average number of errors.

An average score of forty words per minute in a five-minute timed test does not reveal the pattern of speed performance on a minute-to-minute basis. The speed could be 60, 50, 40, 30, and 20 words from the first to the fifth minute respectively. On the other hand, the reverse of this could be true. If there is a distinct pattern of speed performance, in what way does it vary from minute to minute in a timed test? Similarly, the fluctuation of errors from minute to minute in a timed test should be examined.

The five-minute straight-copy timed tests are commonly used in the first year of typewriting to measure students' achievement and to assess grades. If the performance in speed and accuracy were analyzed at the consecutive one-minute intervals of a five-minute test, it might be possible to assess the usefulness of tests of less than five minutes duration. Further research in this area would

help to resolve the controversy concerning the relative merits of the commonly used three-minute and five-minute tests.

PURPOSE OF THE STUDY

The purpose of this study was to determine: (1) the pattern of gross speed performance as indicated by the number of words typed by students in each consecutive one-minute interval of a five-minute straight-copy timed test, and (2) the pattern of accuracy performance as indicated by the number of errors made in each consecutive one-minute interval of the five-minute straight-copy timed test.

HYPOTHESES

This study seeks to test the following hypotheses:

(1) There is no significant difference in the mean type-writing speed achieved by students of Typewriting 10 in the one-minute intervals of a straight-copy five-minute timed test.

(2) There is no significant difference in the mean errors typed by students in the one-minute intervals of a straight-copy five-minute timed test.

In addition to testing the foregoing hypotheses, the study attempted to investigate the average cumulative speed and the average cumulative errors at the end of each minute interval of the four timed writings.

DELIMITATIONS

For the purposes of this study, the duration of the typewriting tests was limited to five minutes because tests of longer duration are not commonly used in Alberta schools.

DEFINITION OF TERMS

Word Any five consecutive typewriting strokes including the space stroke.

Error A violation of any of the Typewriting Contest Rules as set in Gregg Typing, Second Edition.¹

Speed Total number of words typed during the timed test divided by the length of the timed test with no deductions for errors.

Interval Marker A device which indicated on paper consecutive intervals of time of one minute duration.

One-Minute Interval A period of one minute duration in a timed test as indicated by the interval marker.

Syllabic Intensity The average number of syllables in a test per typewritten word.

Cumulative Mean Rate The aggregate of the mean words typed or mean errors made by all students in consecutive one-minute intervals of the tests divided by the number of intervals in the

1. John L. Rowe, Alan C. Lloyd, and Harold H. Smith, Gregg Typing, Second Edition, (New York: Gregg Publishing Division, McGraw-Hill Book Co., 1959), p. xi

accumulation.

Timed Writing In the following chapters, the term "timed writing" will be used interchangeably with the term "timed test".

Typewriting 10 A five credit first-year course in typewriting as outlined in the Alberta Senior High School Curriculum Guide for Business Education.²

2. Department of Education, Province of Alberta, Alberta Senior High School Curriculum Guide for Business Education, Edmonton, Alberta, 1961.

CHAPTER II

REVIEW OF LITERATURE

Many articles appearing in business education journals devote much attention to timed writings in typewriting. It is important to note that the term "timed writing" does not have the same meaning to every writer who discusses the subject. Some speak of timed writings in the context of building speed and accuracy, while others use the term in connection with measures of achievement for the purpose of grading. Some apply the term to all typewriting that is timed, whether it is for skill building, achievement, or production work.

Despite the difference of opinion as to what timed writing is, there is considerable agreement that the length of timed writings should be reduced. In the first year of typewriting, the trend is towards reducing the ten-minute writings to shorter writings of three or five minutes duration.

A SHORT HISTORY OF TIMED WRITINGS

Timed writings of one to fifteen minutes duration were used early in the history of typewriting instruction in high schools. From 1909 to 1919¹, the primary emphasis in timed writings was on accuracy. Later, around 1930², the concept of speed before accuracy made its appearance. With the emphasis on speed, timed writings

1. Russon and Wanous, Philosophy and Psychology of Teaching Typewriting, (Cincinnati: South-Western Publishing Co., 1960), p. 16.

2. Loc. cit.

gradually became shorter. The present technique approach, with emphasis on proper form, employs the one-half and one-minute sprints to build speed and accuracy. Most of our present textbooks are arranged so that students take one-minute writings until they develop enough sustained typing power to take writings of two or three minutes in length. The five-minute writings are introduced towards the end of the first-year course in typewriting. Although the technique approach is relatively new, thirty years ago Dvorak³ advised the teachers as follows:

A queer bias for petty accuracy hinders uncounted typing classes. "Copy" rather than "technique" is wrongly made the objective. Such slow-but-sure repetition has nothing to do with successful typewriting and is even less accurate. Fast correct stroking is not mastered in slow practice.

TIMED WRITINGS AS AN INSTRUCTIONAL DEVICE

With regard to timed writings as an instructional device, Lloyd⁴ states that there are four kinds of timed writings:

1. The Booster Sprint

Purpose: To push skill (speed, or accuracy, or both) up to a new level of performance.

2. The Developmental Timing

Purpose: To extend to several minutes the new rate achieved in the preceding booster sprints (or as much of the new rate as the learner can transfer).

3. Dvorak, Merrick, Dealey, and Ford, Typewriting Behavior, (American Book Company, 1936), p. 301.

4. Alan C. Lloyd, "Four Kinds of Timed Writings," The Business Teacher, Vol. 40, May-June, 1963, p. 11.

3. Production Timed Writing

Purpose: To enable the learner to apply his new basic-skill rate to practical purposes, and to sustain his rate, which was developed on simple paragraph material, to longer and harder material.

4. Test Timed Writings

Purpose: To measure the student's momentary level of accomplishment, with no pretense that the taking of the test will make him a better typist. All timed efforts longer than two minutes, conducted without preview or repetition, fall in this category.

It should be observed that Lloyd regards production work as a timed writing. He suggests that the length of effort should reach as high as, but not exceeding, five minutes. The students are to be given an opportunity to start on arranged material for the first semester but thereafter, the unarranged materials are to be used.

TIMED WRITINGS AND PRODUCTION WORK

Several studies were completed to determine the degree of transfer of learning that takes place when achievement on straight-copy timed writings is compared with achievement on problem-solving jobs. Reigel⁵ reports a Pearson-Product correlations of 0.87 between straight-copy timed tests of five minutes and the production test consisting of the same material as in the straight-copy. The test in production consisted of business letters. The body of the business letter was the same as the material in the straight-copy test. It

5. Charles Reigel, "Correlation of Straight-Copy and Production of Typewriting," Business Education Forum, October, 1959, pp. 21, 22.

can be reasonably assumed that if the material in the production test were different and unarranged, the correlation coefficient would be considerably less.

In a study involving 194 typewriting students in seven Wisconsin high schools Jiles⁶ gives, in part, the following findings:

1. The median straight-copy rate was 46 words a minute.
2. The median production rate was 10 words a minute, or 21.1 per cent of median straight-copy rate.
3. No significant coefficients of correlation were obtained in any pairing of the factors of production quality, production rate, and straight-copy rate.

In determining the relationship between straight-copy typing skill and performance on job-type activities, West⁷ reports a correlation of 0.50 between gross straight-copy speed and speed at the various job-type activities including business correspondence, one-page table, one-page manuscript with footnotes, one-page rough draft, and a letter containing a table. The job-type activities were unarranged, requiring students to make decisions. On the basis of this study, West concludes that only one-quarter of the factors that underlie straight-copy speed also underlie speed at job activities.

Crawford⁸ completed a study in 1956 to determine the effect of

6. Russel F. Jiles, "A Survey of Production Rates and Production Quality of Third Semester Typing Students in Selected Wisconsin High Schools", National Business Education Quarterly, Vol. 27, 1958-59, pp. 37, 38.

7. Leonard J. West, "Some Relationships Between Straight-Copy Typing Skill and Performances on Job-Type Activities", National Business Education Quarterly, Vol. 30, 1961-62, p. 62.

8. Thomas James Crawford, "The Effect of Emphasizing Production Typewriting Contrasted With Speed Typewriting in Developing Production Typewriting Ability", Monograph 97, (South-Eastern Publishing Co., 1960)

emphasizing production typewriting contrasted with speed typewriting in developing production typewriting ability. When the performance of the control and experimental groups was compared at the end of the year, it was found that the control group which received training in production work showed significantly better results on genuine typing jobs than the experimental group which spent their training time largely devoted to straight copy skill.

On the basis of his findings, he makes this suggestion:

The evidence did not show any over-all loss in net stroking skill due to the emphasis placed upon production typewriting. From the evidence compiled, it was found that classes emphasizing speed did not gain as much in production as those emphasizing production; on the other hand, it was found that the classes emphasizing production gained in net stroking, more in one instance and approximately as much in the other, as the classes devoting two thirds of their instruction time to speed building. Thus, it appears that opportunities for greater over-all development tend to be greater under the production-emphasis, rather than the speed-emphasis method. It is suggested, then, that teachers interested in increasing net stroking rates while, at the same time developing production power, seriously consider the desirability of providing intensive training in production typewriting as an approach to the realization of both objectives.⁹

Research studies which were cited thus far indicate that straight-copy work has received too much time and attention in the average classroom. This mounting evidence has prompted West¹⁰ to suggest the following changes in typewriting instruction:

1. Drop the incessant focus on straight copy skill and

9. Loc. cit.

10. John L. Rowe, Editor, Methods of Teaching Typewriting, (New York 3: The Eastern Business Teachers Association Yearbook, Vol. 38, 1965), p. 11.

concentrate in increasingly larger amounts as training proceeds on real job activities. On this score it may be suggested that real life jobs claim at least half the practice time starting with about the middle of the first semester and something on the order of 90 per cent of the time starting with the second semester and thereafter.

2. In the work on real life typing jobs, there is little to be gained from practice at arranged copy. For each new type of task, a few tries from arranged copy are probably desirable and helpful; but move immediately and continuously thereafter to unarranged copy in which the typist must make all his own decisions. In this respect, the wealth of detailed instructions given for each task in current typing textbooks--as compared to the proportion of unarranged materials unaccompanied by detailed instructions--is dead wrong and should be completely reversed.¹¹

It would be wrong to conclude at this point that timed writings will disappear as an instructional device. They will continue to be used. It appears to be a matter of shift in emphasis. Once the student reaches appropriate levels of speed and accuracy, production work should receive its proper degree of attention and time.

Russon¹² has this in mind when he says:

Perhaps if the attitude toward straight-copy writings were changed and they were considered to be learning devices rather than testing devices, they would more likely be assigned their rightful place in the scheme of things.

When production work takes its due place in typewriting instruction, some thought will have to be given to standards of achievement in job-type activities. Clem¹³ points to the problem by saying:

In conclusion, it should be said that there is available

11. Loc. cit.

12. Russon and Wanous, op. cit., p. 390.

13. Jane E. Clem, Techniques of Teaching Typewriting, (New York: McGraw-Hill Book Company, 1960), p. 291.

no satisfactory system of measuring the typist's progress in developing skills of a practical nature. Such a plan would be difficult to construct, the chief obstacle being in arriving at the proper unit of measurement. It cannot be the letter, because that varies in length and in arrangement; nor the word, for that does not consider the element of arrangement.

LENGTH OF TIMED WRITINGS

Timed writings of various length are used to measure levels of accomplishment as well as skill building. For testing purposes, Russon and Wanous¹⁴ make the following statement on the optimum length of straight-copy writings:

The 10- and 15-minute straight-copy tests are being replaced, in the main, by writings of shorter duration. Many textbook writers advocate the use of 1-minute writings until the student has developed sufficient sustained typing power to type for three minutes. The 3-minute writing is then used for about half the semester; and the 5-minute writing is introduced toward the end of the first semester and used thereafter. Ten-minute writings may be used, of course, at the discretion of the teacher; but it appears that most of the advantages of the 10-minute writings are found in one of 5 minutes.

Lloyd¹⁵ cautions the teachers not to overlook the problem of fatigue in a typewriting course. In typewriting, the student strains the muscles of the back, neck, shoulders, arms and hands into new angles, new kinks, and new twists. This fatigue produces negative techniques which are injurious to his practice. To avoid the dangerous impact of fatigue, he suggests the following maximum lengths of timed writings:

14. Russon and Wanous, op. cit., p. 394.

15. Alan C. Lloyd, "The Problems of Fatigue", Business Teacher, September-October, 1963, p. 39.

1. A learner should not attempt 5-minute timings before he can type 35 wpm for 3 minutes.
2. A learner should not attempt 7-minute timings before he can type 50 wpm for 5 minutes.
3. A learner should not attempt 10-minute timings before he can type 60 wpm for 7 minutes.

To violate these thumb guides is to invite injurious practice--to give drill in bad typing--and so to retard the growth rate of the learner.¹⁶

For the purpose of skill building, Rowe¹⁷ sets the maximum limit of time at three minutes. He comments:

There is increasing evidence that one types at his optimum or maximum rate of speed for a period of approximately two or three minutes. After that time, his typewriting score reflects the element of fatigue. If it is possible to measure speed growth by the shorter timed writing, then this length should be more widely used. It is possible for the student to have many more tries through the use of short timings, and it doesn't take forever to measure his progress. Although it may be many years before the recommended practice takes effect in the classroom, the 3-minute timed writing is probably the most effective measure of skill growth--even more than the 5-minute writing. The 10- and 15-minute timings become little more than endurance contests.

Shelor¹⁸ conducted a study to determine whether three-minute timed writings were as effective as five-minute timed writings in the development of basic skill in typewriting. She discovered that

16. Loc. cit.

17. John L. Rowe, "How to Meet Changing Needs in Typewriting", Business Education World, February, 1964, p. 31.

18. N. V. Shelor, "An Experiment to Determine Whether Three-Minute Timed Writings Are as Effective as Five-Minute Writings in Developing of Basic Skill in Typewriting", National Business Education Quarterly, Vol. 27, p. 67.

students are more relaxed when typewriting for short periods of time and that short drills control the factor of fatigue when the student is exercising new combinations of muscles. Her findings were:

1. When measured by the last writing in each rotation period over 100 lessons, students increased their stroking rates by 47.7 more strokes a minute when taking three-minute writings than when taking five-minute writings.
2. On a point basis, combining speed and accuracy, students increased their performance more when taking three-minute writings than when taking five-minute writings.

In regard to the relative merits of one-, three-, and five-minute timed writings in skill building and evaluation, Rowe and Peterson¹⁹ raised this question:

Within recent years the use of the five-minute timed writings has generally become accepted as a major typewriting skill-building procedure and measuring device. It is apparently as effective as the practice of using fifteen-minute "tests" of a former era. Is the three-minute or the one-minute timing as satisfactory as the five-minute?

Atwood²⁰ supplied part of the answer by a recent study which he completed at the University of North Dakota. He compared the performance of first year students on a three-minute straight-copy test with performance on a ten-minute test. By taking photographic slides of each student's performance at one-minute intervals of the test, he was able to determine the speed and errors of each student during

19. E. A. Dvorak, Informal Research by the Classroom Business Teacher, Eastern Business Teachers Association Yearbook, Vol. 18, (Somerville: Somerset Press, 1961), p. 139.

20. Dale T. Atwood, "Periodicity of Effort in Beginning Typewriting", (Unpublished Ed. D. dissertation, University of North Dakota, 1964), pp. 234, 235.

each minute interval of the three- and ten-minute tests. Having this information, he was able to arrive at the cumulative average gross speed as well as cumulative average errors. The students were subjected to two testing periods. The first testing session took place during the ninth week of class instruction when two three-minute and two ten-minute straight-copy timed writings were administered. The same tests were administered again during the eighteenth week of class instruction. Part of his findings were as follows:

1. The fastest one-minute interval stroking rate was recorded in the first-minute interval for all three- and ten-minute timed writings. Nearly all students type faster the first minute than any other minute and the largest mean one-minute interval gross speed rates were recorded in the first minute for all writings.
2. There was a sharp decrease in stroking speed during the second-minute interval of the three- and ten-minute writings.
3. The mean one-minute interval gross speed rate pattern indicated a decrease in the second minute with an erratic but gradual decrease from there through the tenth interval.
4. There was a decisive drop in stroking speed after the first three minutes which continued rather steadily to the tenth-minute interval of the ten-minute writing.
5. Stroking speed and error occurrence as indicated by cumulative average speed and error rates were approximately the same for the three-minute writings as those recorded in the first three minutes of the ten-minute writings.²¹

The findings of research studies cited indicate that the most efficient timed writing test is the one of three minutes duration. The element of fatigue is reflected by the gradual decrease of

21. Loc. cit.

cumulative speed and the gradual increase in cumulative errors after three minutes of typing.

A review of recent literature reveals the need for additional studies to examine speed and accuracy performance at one-minute intervals on straight-copy timed writings. Although a number of studies were completed which dealt with speed and accuracy on straight-copy timed writings, only one study dealt specifically with the speed and accuracy performance at one-minute intervals of the timed writings.

In the study by Atwood, the students were brought into the classroom in small groups no larger than five. The photographers were stationed behind each student to take photographic slides at intervals of one minute while the students took their tests. It appears that such a method of obtaining data would be somewhat disconcerting to the students and therefore interfere with their best typewriting performance. An improved method of obtaining data would be one in which the entire class could take the timed writings in their regular classroom periods. It would be equally desirable to remove the photographers and obtain the data at one-minute intervals by means of some electrical device attached to the typewriters and controlled by a master switch. If the conditions under which required data is obtained were to approximate existing classroom conditions, the results would reflect more closely the actual performance of the students.

CHAPTER III

PROCEDURE

Chapter III consists of a description of the population included in the study, the machine attachment used for marking intervals of one minute duration, the procedures used in selecting and administering typewriting tests, and the procedures used for determining speed and errors.

THE POPULATION

The population included the eighty-four students who were enrolled in all three classes of Typewriting 10 in Fort Saskatchewan High School during the 1963-64 school year. All subjects were taking Typewriting 10 for the first time and all were using manual typewriters in their regular classroom instruction.

APPARATUS FOR MEASURING ONE-MINUTE INTERVALS

In order to determine the number of words typed in each consecutive one-minute interval, an interval marker was attached to each typewriter. (See Figure 1, page 17.) Each interval marker was electrically controlled and attached to a line leading to the master switch. When the switch was depressed at the end of each minute, the marking points of all the interval markers were activated simultaneously to leave a dot on the paper. Each dot located the position of the last letter struck during any one-minute interval.

FIGURE 1



Interval Marker Mounted on Typewriter

FIGURE 2

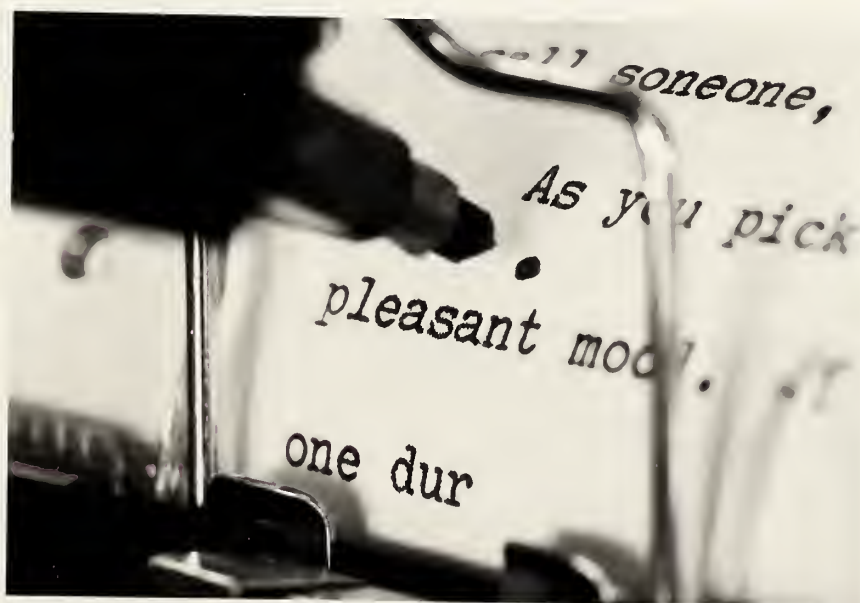
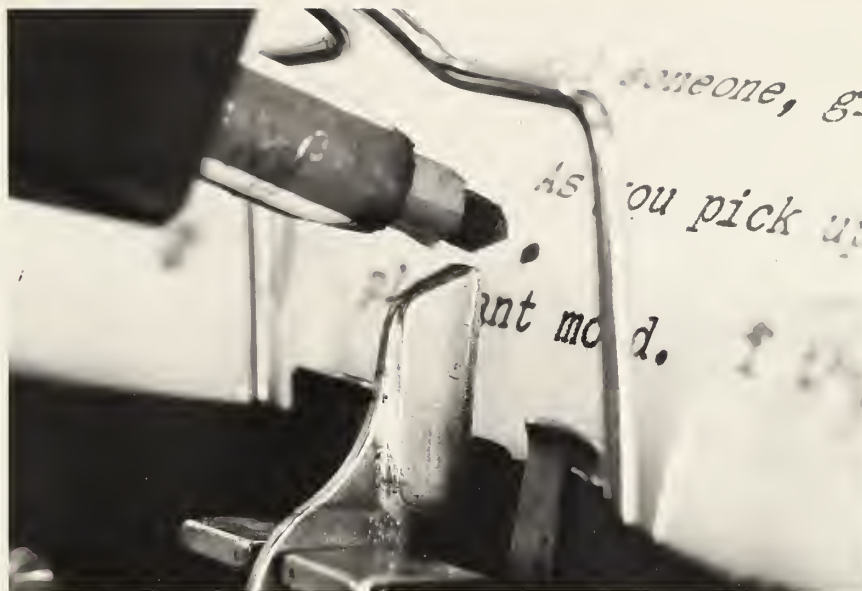
Close-up Showing Position of Dot in Relation
to the Last Letter Struck

FIGURE 3



Close-up Showing Position of Marker Point
in Relation to Type Bar

In Figure 2, page 17, the close-up shows clearly the position of the dot in relation to the last letter struck at the end of a one-minute interval. When the letter "r" in the word "during" was struck, the dot appeared three line spaces above. In this case, it appeared above "n" in the word "pleasant". This dot appeared three line spaces above the letter "r" because the point of the marker had to give clearance to the movement of the type bar. (See Figure 3, page 18.) In order to locate the last letter struck at the end of each one-minute interval, it was necessary to drop three line spaces from the position of the dot.

SELECTION OF TIMED TESTS

To get a reliable measure of speed and accuracy of the Typewriting 10 students, it was decided to set up a testing program consisting of four five-minute timed tests of approximately equal difficulty. Accordingly, four tests of equal syllabic intensity (1.30) and of similar content to the typewriting text material were chosen. The 20th Century Typewriting Tests, Nos. 5, 6, 7, and 8 best met the above criteria and were therefore selected for the testing program.¹

The length of each line of the 20th Century Typewriting Tests was reduced from seventy strokes to fifty strokes. This adaptation was made because the students were accustomed to using a fifty-stroke

1. Published by South-Western Publishing Company, Cincinnati, Ohio.

line. Slight revisions² were made in the wording of the 20th Century Tests so that the syllabic intensity of each line of the tests would fall within the range 1.25 to 1.33. The average syllabic intensity of each of the four tests was 1.30.

The revised tests were accompanied by a paragraph of type-written material for pre-test practice or warm-up. The pre-test practice materials were similar to the tests in length of line and syllabic intensity.

ADMINISTRATION OF TYPEWRITING TESTS

Two months before the administration of tests prepared for this study, the teacher of typewriting was consulted to discuss some of the problems related to the testing program and to prepare the students of Typewriting 10 classes for the tests. The teacher reported that the classes concerned were accustomed to three-minute timed writings. Since the tests to be taken were five minutes in length, the teacher agreed to give students five-minute timed writings each week for six weeks prior to the commencement of the testing program.

The interval markers were attached to the typewriters one week before the tests were administered so that students could get accustomed to their presence. On the day prior to the commencement of the tests, all students were given a trial warm-up paragraph and

2. Permission to revise tests granted by publishers.

a five-minute pre-test to become further acquainted with the performance of the markers and the necessary adjustments. The pre-test material found in Appendix C and the actual test materials were similar in syllabic intensity and length of line. Before the tests were taken, the students were familiar with the nature of the tests, the type of instructions, and the required machine adjustments.

The four tests were assigned randomly to students during the four consecutive test days and the class list, Appendix B, was prepared to show the order in which each student would take the tests. During the four days of the testing program, the students were not allowed to use the typewriters for any additional practice. The tests were administered by the investigator in May, 1964.

Each test day, students were provided with two blank sheets of paper and instructions for making proper adjustments to the machine (See Appendix B) were read. At the end of five minutes, the students were instructed to stop typing.

SCORING PROCEDURES

After the timed writing tests were completed, they were scored for errors and the number of words typed during each successive one-minute interval. The manner in which the tests were scored is illustrated in Figure 4, page 22. Since the dot appears three single line spaces above the letter being struck at the end of each minute interval, it is possible to determine the number of words typed and the number of errors made in each one-minute interval of the timed

FIGURE 4

Timed Writing 4

No. of
WordsNo. of
Errors

When the telephone rings, answer it at once.

36

The person on the other end may not realize that you are there and may hang up before you finally decide to take the receiver in your hand. When you call someone, give him time to reach the telephone.

0

34

As you pick up the receiver, drop every unpleasant mood. If the working day has been a trying one during which everything went wrong, put the

1

34

upsetting thoughts out of your mind before answering the telephone. When speaking, put all the charm you possess into your voice. The cold, below-zero voice has no place on any phone conversation. Make your voice sound warm and courteous.

0

28

Do not forget to address the person you are speaking to by name. Like all other men and women, he likes to hear his own name. If you superior is not in his office at the moment, take the memo pad and write down the name and tele

2

33

2

writing.

The first dot appearing above the "u" in the word "you" indicates the last letter typed by a student at the end of the first minute of typing. In this example, the student typed thirty-eight words and made no errors in the first minute. The second dot, appearing three line spaces above the letter "r" in the word "everything" indicates the last letter struck in the second interval of one minute duration. The number of words typed in the second interval was thirty-four and the number of errors was one. The same procedure was used in scoring the number of words typed and the number of errors made in each minute interval of the tests.

The analysis of variance was the technique used to test the following hypotheses:

(1) There is no significant difference in the mean typewriting speed achieved by students of Typewriting 10 in the one-minute intervals of a straight-copy five-minute timed test.

(2) There is no significant difference in the mean errors typed by students in the one-minute intervals of a straight-copy five-minute timed test.

CHAPTER IV
ANALYSIS OF DATA AND FINDINGS

The following chapter is divided into four parts. In Part I, the timed writings are tested for parallel forms by using the gross speed scores and error scores. This procedure was used to show that the four tests were of approximately equal difficulty. In Part II, the mean gross speed at one-minute intervals is examined for significant differences. The results of this analysis were used in testing the first hypothesis. The mean errors at one-minute intervals are examined in Part III for significant differences, after which, the second hypothesis is tested. Patterns of gross speed, cumulative gross speed, errors, and cumulative errors are found in Part IV.

PART I

TESTS FOR PARALLEL FORMS BASED ON GROSS SPEED

Test for Homogeneity of Variance in Gross Speed

To test for the homogeneity of variance in gross speed, the¹ Hartley formula was used.

$$F_{\max} = \frac{s_{\text{largest}}^2}{s_{\text{smallest}}^2}$$

1. B. J. Winer, Statistical principles in Experimental Design, (New York: McGraw-Hill Book Company, 1962), p. 92

By substituting in the formula the values for the variances appearing in Table I, F_{\max} was computed as follows:

$$F_{\max} = \frac{62.82}{52.48} = 1.20.$$

The critical value of F_{\max} was found to be 1.96 at the .05-level, where $k = 4$ and $df = 60$. On the basis of this data, it was concluded that the variances in gross speed for the four timed writings were homogeneous because the observed F_{\max} , 1.20, was less than the given critical ratio of 1.96.

Test for Significant Difference of Means in Gross Speed

The analysis of variance was used to test for difference of means in gross speed over the four testing periods. Since all students did not take all four tests, the computational formulas used for the analysis of variance were those which apply to repeated measures on unequal groups.² Table I summarizes the data for this analysis giving total scores, sums of squares, variances, and mean scores for the four timed writings.

In Table II, the F-ratio was computed to be 0.38. The critical values of F were found to be 3.86 at the .01-level of significance, and 2.63 at the .05-level. Since these critical values were higher than the observed F-ratio, 0.38, it was concluded that the mean gross speed scores on the four timed tests were not signi-

2. Ibid., p. 96

TABLE I

SUMMARY OF ANALYSIS OF VARIANCE DATA FOR GROSS SPEED
ON FOUR FIVE-MINUTE TIMED WRITINGS

Test 1	Test 2	Test 3	Test 4	
$n_1 = 1177$	$n_2 = 1076$	$n_3 = 75$	$n_4 = 72$	$N = 300$
$*T_1 = 2,623.2$	$T_2 = 2,527.2$	$T_3 = 2,545.0$	$T_4 = 2,371.2$	$G = 10,066.6$
$\sum X_1^2 = 93,354.16$	$\sum X_2^2 = 88,747.60$	$\sum X_3^2 = 90,995.48$	$\sum X_4^2 = 81,918.48$	$\sum \sum X_j^2 = 355,015.72$
$\frac{T_1^2}{n_1} = 89,365.95$	$\frac{T_2^2}{n_2} = 84,036.05$	$\frac{T_3^2}{n_3} = 86,360.33$	$\frac{T_4^2}{n_4} = 78,091.52$	$\sum \frac{T_j^2}{n_j} = 337,853.85$
$SS_1 = 3,988.21$	$SS_2 = 4,711.55$	$SS_3 = 4,635.15$	$SS_4 = 3,826.96$	$\sum SS_j = 17,161.87$
$s_1^2 = 52.48$	$s_2^2 = 62.82$	$s_3^2 = 62.63$	$s_4^2 = 53.90$	
$\bar{X}_1 = 34.07$	$\bar{X}_2 = 33.25$	$\bar{X}_3 = 33.93$	$\bar{X}_4 = 32.93$	$\bar{G} = 33.56$

$$(1) G^2/N = 337,788.12 \quad (2) \sum \sum X_j^2 = 355,015.72 \quad (3) \sum (T_j^2/n_j) = 337,853.85$$

$*T_n$ = Total score of all students in a given test.

TABLE II
ANALYSIS OF VARIANCE OF GROSS SPEED
ON FOUR FIVE-MINUTE TIMED WRITINGS

Source of Variation	Sums of Squares	df	Mean Squares	F
Between Tests	65.73	3	21.91	0.38
Within Tests	17,161.87	296	57.98	
Total	17,227.60	299		

$$F_{.95}(3,296) = 2.63$$

$$F_{.99}(3,296) = 3.86$$

ificantly different.

Intercorrelations of Gross Speed

In computing the gross speed correlations, the following formula was used:³

$$r_{xy} = \frac{\text{Cov. } XY}{\sqrt{(\text{Var. } X)(\text{Var. } Y)}}$$

Raw gross speed scores were used in the above formula to compute the intercorrelations of the four timed writings.

The intercorrelations matrix given in Table III shows that any two timed tests were highly correlated. All correlations fell within the range 0.94 to 0.97.

TABLE III
INTERCORRELATIONS OF GROSS SPEED ON FOUR
FIVE-MINUTE TIMED WRITINGS

	Test 1	Test 2	Test 3	Test 4
Test 1	1.00	0.95	0.95	0.94
Test 2		1.00	0.97	0.96
Test 3			1.00	0.96
Test 4				1.00

3. George A. Ferguson, Statistical Analysis in Psychology and Education, (New York: McGraw-Hill Book Company, 1959), p. 92

Because the correlations were high, the variances were homogeneous, and the means of the gross speed were not significantly different, it was concluded that the four timed writings were parallel in form when used to measure the gross speed performance of the students.

TESTS FOR PARALLEL FORMS BASED ON ERRORS

The tests for parallel forms based on errors are similar to those used in testing for parallel forms based on gross speed.

Test for Homogeneity of Variance in Errors

The error variances given in Table IV were used in Hartley's test for homogeneity of variance.

$$F_{\max} = \frac{s_{\text{largest}}^2}{s_{\text{smallest}}^2} = \frac{2.10}{1.46} = 1.44$$

The critical value of $F_{\max}^{.95} = 1.96$, where $k = 4$ and $df = 60$. Since the computed F_{\max} , 1.44, did not exceed the critical value at the .05-level, it was concluded that the error variances for the four timed tests were homogeneous.

Test for Significant Difference in Error Means

Since all students did not take all four tests, the computational formulas used for the analysis of variance were those which apply to repeated measures on unequal groups.

TABLE IV
SUMMARY OF ANALYSIS OF VARIANCE DATA FOR ERRORS
ON FOUR FIVE-MINUTE TIMED WRITINGS

Test 1	Test 2	Test 3	Test 4
$n_1 = 77$	$n_2 = 76$	$n_3 = 75$	$n_4 = 72$
$*T_1 = 191.7$	$T_2 = 189.0$	$T_3 = 209.00$	$T_4 = 181.6$
$\sum X_1^2 = 588.25$	$\sum X_2^2 = 619.24$	$\sum X_3^2 = 737.64$	$\sum X_4^2 = 602.00$
$\frac{T_1^2}{n_1} = 477.26$	$\frac{T_2^2}{n_2} = 470.01$	$\frac{T_3^2}{n_3} = 582.41$	$\frac{T_4^2}{n_4} = 458.04$
$SS_1 = 110.99$	$SS_2 = 149.23$	$SS_3 = 155.23$	$SS_4 = 143.96$
$s_1^2 = 1.46$	$s_2^2 = 1.99$	$s_3^2 = 2.10$	$s_4^2 = 2.03$
$\bar{X}_1 = 2.49$	$\bar{X}_2 = 2.45$	$\bar{X}_3 = 2.71$	$\bar{X}_4 = 2.50$
			$\bar{C} = 2.57$
			$\sum \sum X_j^2 = 2547.13$
			$\sum \frac{T_j^2}{n_j} = 1987.72$
			$\sum SS_j = 559.41$
			$\bar{C} = 2.57$

$$(1) \frac{G^2}{N} = 1983.01 \quad (2) \sum \sum X_j^2 = 2547.13 \quad (3) \sum (T_j^2/n_j) = 1987.72$$

* T_n = Total score of all students in a given test.

By using the data found in Table IV, the analysis of variance for errors was computed and presented in Table V. Because critical values $F_{.95}(3,296) = 2.63$ and $F_{.99}(3,296) = 3.86$ were both higher than the observed F-ratio, it was concluded that the error means for the four tests were not significantly different.

TABLE V
ANALYSIS OF VARIANCE FOR ERRORS
ON FOUR FIVE-MINUTE TIMED WRITINGS

Source of Variation	Sums of Squares	df	Mean Squares	F
Between Tests	4.71	3	1.57	0.83
Within Tests	559.41	296	1.89	
Total	564.12	299		

$$F_{.95}(3,296) = 2.63$$

$$F_{.99}(3,296) = 3.86$$

Intercorrelations of Errors

As shown in Table VI, the intercorrelations of errors on the four timed writings varied from 0.52 to 0.64. The correlations for gross speed varied from 0.94 to 0.97. The lower correlations for errors indicate that the accuracy performance of students is not as consistent as the speed performance.

The above correlations for speed and errors are similar to those reported by West⁴ and Martin⁵. West found that speed correlations varied from 0.85 to 0.91 while the correlations for errors fell within the range of 0.43 to 0.51. Martin reported speed correlations of 0.80 to 0.83 and error correlations of 0.36 to 0.40.

TABLE VI
INTERCORRELATIONS OF ERRORS ON FOUR
FIVE-MINUTE TIMED WRITINGS

	Test 1	Test 3	Test 3	Test 4
Test 1	1.00	0.64	0.61	0.55
Test 2		1.00	0.57	0.52
Test 3			1.00	0.55
Test 4				1.00

4. Leonard J. West, "Practice Sets Towards Speed and Accuracy in a Skill Building Program in Elementary Typewriting", National Business Education Quarterly, Vol. 21, March 1953, pp. 46-55.

5. George E. Martin, "The Effects of Using Continuous and Interval Speed-Forcing Program in Learning to Typewrite", National Business Education Quarterly, Vol. 23, March 1955, pp. 37-43.

PART II

ANALYSIS OF GROSS SPEED AT ONE-MINUTE INTERVALS

The average gross speed at one-minute intervals for each of the seventy-six students was obtained by adding the gross speed in each one-minute interval of the tests and dividing by the number of tests written. The data appear in Table VII.⁶

Since the gross speed of the five-minute tests is being examined at one-minute intervals for the purposes of this study, each of these intervals could now be considered as a timed writing of one-minute duration. Because the number of students considered in each one-minute interval was the same and because each student was subjected to the same number of one-minute writings, it was possible to use the analysis of variance which applies to repeated measures on the same number of elements⁷ for testing the following hypothesis:

There is no significant difference in the mean typewriting speed achieved by students of Typewriting 10 in the one-minute intervals of a straight-copy five-minute timed test.

The data for the analysis of variance is found in Table VIII. Using this data, the analysis of variance for repeated measures of

6. Students who missed two or more tests, were not included in Table VII.

7. Winer, op. cit. p. 105

TABLE VII
AVERAGE GROSS SPEED AT ONE-MINUTE INTERVALS
ON FOUR FIVE-MINUTE TIMED WRITINGS

Student Number	One-Minute Intervals				
	1	2	3	4	5
1	48.00	45.00	48.25	46.50	49.00
2	27.50	22.50	18.75	24.50	23.00
3	25.50	22.75	21.00	22.75	21.50
4	27.50	28.75	30.75	28.50	27.50
5	34.50	30.25	35.00	30.50	33.50
6	36.75	34.75	38.75	39.00	38.50
7	37.25	34.75	36.50	38.00	39.00
8	43.25	42.50	43.00	48.00	44.75
9	36.25	33.50	35.25	37.75	36.00
10	33.50	31.00	32.50	31.50	34.50
11	32.50	28.00	30.00	28.25	31.25
12	27.75	22.25	25.50	28.00	27.50
13	36.00	34.25	37.25	38.00	39.50
14	27.50	23.25	25.50	24.25	23.00
15	33.25	30.25	32.25	33.75	35.25
16	25.50	23.50	23.00	22.75	21.75
17	32.25	33.50	33.75	34.75	32.50
18	41.75	39.00	36.25	37.25	38.25
19	33.25	29.50	30.25	29.50	29.25
20	23.50	21.25	21.25	22.25	21.50
21	34.25	30.25	32.75	33.75	35.00
22	42.50	41.50	41.25	42.75	42.75
23	35.75	32.25	32.75	35.25	34.50
24	28.75	29.25	25.25	26.50	25.75
25	34.25	37.00	39.00	40.75	42.25
26	35.75	37.25	36.75	38.00	33.50
27	32.25	34.75	32.75	29.25	36.50
28	34.25	32.25	30.25	32.00	30.25
29	29.75	25.50	25.00	24.75	26.50
30	29.00	26.50	25.25	26.50	23.75
31	45.25	40.50	41.75	42.75	46.25
32	41.75	39.50	39.50	39.50	37.00
33	28.50	26.75	28.00	28.25	28.75
34	29.50	25.75	27.00	27.00	26.25
35	33.50	30.50	31.25	30.50	31.75
36	28.25	23.25	25.25	25.75	25.50
37	39.50	36.25	39.75	37.75	40.00
38	30.75	24.00	21.75	25.50	25.50
39	40.75	37.50	40.75	39.00	39.00
40	50.50	54.00	54.50	52.75	49.25

TABLE VII (Continued)

AVERAGE GROSS SPEED AT ONE-MINUTE INTERVALS
ON FOUR FIVE-MINUTE TIMED WRITINGS

Student Number	One-Minute Intervals				
	1	2	3	4	5
41	32.25	28.00	27.25	26.50	30.25
42	34.00	30.75	30.50	30.00	33.50
43	44.25	41.75	39.50	43.50	42.25
44	24.75	22.00	20.25	19.25	20.75
45	42.50	36.00	40.25	41.75	43.25
46	26.00	23.75	22.00	25.75	23.00
47	38.25	25.50	38.00	34.50	36.00
48	46.25	43.75	46.25	48.75	42.00
49	42.25	37.25	41.25	41.50	43.00
50	37.50	32.25	31.00	31.50	33.00
51	34.25	29.50	33.50	36.00	33.75
52	32.00	29.50	25.50	29.25	30.75
53	47.00	46.50	44.50	45.75	48.25
54	28.00	26.75	25.00	24.75	24.75
55	29.00	26.67	27.33	26.00	24.67
56	39.00	39.33	36.00	39.00	38.00
57	31.33	28.67	30.00	30.67	30.33
58	44.00	42.33	43.67	40.33	45.00
59	40.67	37.67	38.33	40.67	37.33
60	33.33	29.00	26.33	27.67	31.33
61	35.33	30.00	30.00	31.33	33.00
62	30.67	29.00	27.67	29.33	30.33
63	49.33	43.33	47.00	48.33	49.00
64	35.67	37.33	34.33	36.00	35.67
65	28.00	24.00	25.33	24.67	24.00
66	30.67	31.67	28.00	28.67	32.33
67	46.33	46.00	44.00	46.00	46.00
68	37.67	36.33	37.33	36.67	38.67
69	31.00	31.33	27.33	28.00	31.33
70	52.67	45.67	48.67	52.00	49.67
71	40.33	38.67	31.00	33.00	38.67
72	31.33	29.00	30.00	28.33	29.33
73	34.00	30.67	31.33	29.33	31.33
74	24.67	24.33	21.67	22.00	25.67
75	40.67	45.33	46.67	49.33	45.00
76	30.33	28.00	26.33	27.33	30.00
Mean	35.17	32.80	33.00	33.51	33.92

TABLE VIII

SUMMARY OF ANALYSIS OF VARIANCE DATA FOR AVERAGE GROSS SPEED
AT ONE-MINUTE INTERVALS ON FOUR FIVE-MINUTE TIMED WRITINGS
(n = 76 students)

1st Minute Interval	2nd Minute Interval	3rd Minute Interval	4th Minute Interval	5th Minute Interval	
$*T_1 = 2,673.25$	$T_2 = 2,492.58$	$T_3 = 2,508.32$	$T_4 = 2,547.41$	$T_5 = 2,578.16$	$G = 12,799.72$
$\sum X_1^2 = 97,505.08$	$\sum X_2^2 = 85,642.80$	$\sum X_3^2 = 87,460.54$	$\sum X_4^2 = 90,900.06$	$\sum X_5^2 = 92,676.22$	$\sum \sum X_j^2 = 454,184.70$
$T_1^2 = 7,146,265$	$T_2^2 = 6,212,955$	$T_3^2 = 6,291,699$	$T_4^2 = 6,489,298$	$T_5^2 = 6,646,909$	$\sum T_j^2 = \frac{431,409}{n}$
$SS_1 = 3,475.27$	$SS_2 = 3,893.39$	$SS_3 = 4,675.42$	$SS_4 = 5,514.56$	$SS_5 = 5,216.89$	$\sum SS_j = 22,775.53$
$s_1^2 = 46.34$	$s_2^2 = 51.91$	$s_3^2 = 62.34$	$s_4^2 = 73.53$	$s_5^2 = 69.56$	
$\bar{T}_1 = 35.17$	$\bar{T}_2 = 32.80$	$\bar{T}_3 = 33.00$	$\bar{T}_4 = 33.51$	$\bar{T}_5 = 33.92$	

$$(1) G^2/kn = 431,139.03 \quad (2) \sum \sum X_j^2 = 454,184.70 \quad (3) \sum T_j^2/n = 431,409.17 \quad (4) \sum P^2/kn = 453,003.04$$

* T_j = Total score for any given interval.

gross speed was computed as shown in Table IX. The data yielded an F-ratio of 22.22.

The critical values $F_{.99}(4,300) = 3.39$ and $F_{.95}(4,300) = 2.40$ are both less than the observed F-ratio. The first hypothesis was therefore rejected. The analysis of variance indicated a significant difference in the means of the gross average speed at one-minute intervals.

Tests on Differences in Average Gross Speed

Between Pairs of Means

The Newman-Keuls method was employed to determine which means at one-minute intervals were significantly different.⁸ The total scores for each one-minute interval were arranged in ascending order. Since the number of cases was the same in each minute interval, the total score was used in this test rather than the means. An examination of Table X shows that the mean gross speed achieved by students was significantly higher in the first one-minute interval than in any subsequent minute interval. The speed in the fifth minute interval was significantly higher than the speed attained in the second and third one-minute intervals. After the initial drop in speed in the second one-minute interval, the students regained some of this speed in the succeeding intervals.

8. Ibid., p. 114

TABLE IX
ANALYSIS OF VARIANCE FOR GROSS SPEED AT ONE-MINUTE INTERVALS
ON FOUR FIVE-MINUTE TIMED WRITINGS

Source of Variation	Sums of Squares	df	Mean Squares	F
Between People	21,864.01	75		
Within Person	1,181.66	304		
Tests	270.14	4	67.54	22.22*
Residual	911.52	300	3.04	
Total	23,045.67	379		

$$*F_{.99}(4, 300) = 3.39$$

$$*F_{.95}(4, 300) = 2.40$$

TABLE X
TESTS ON DIFFERENCES BETWEEN PAIRS OF MEANS FOR
AVERAGE GROSS SPEED AT ONE-MINUTE INTERVALS

(n = 76 students)

Interval		2	3	4	5	1
	Totals	2492.58	2508.32	2547.41	2578.16	2773.25
2	2492.58	-----	15.74	54.83	85.58*	180.67*
3	2508.32		-----	39.09	69.84*	164.93*
4	2547.41			-----	30.75	125.84*
5	2578.16				-----	95.09*
1	2673.25					-----
$q_{.99}(r, 300) =$				3.64	4.12	4.40
$\sqrt{nMS_{res}}[q_{.99}(r, 300)] =$				55.69	63.04	67.32
					70.38	

*Significantly different pairs of means

PART III

ANALYSIS OF ERRORS AT ONE-MINUTE INTERVALS

The average number of errors at one-minute intervals for each of the seventy-six students was obtained by adding the number of errors in each one-minute interval of the tests and dividing by the number of tests written. The data appear in Table XI.⁹

Because the average number of errors is examined at one-minute intervals over a five-minute test, the analysis of variance for repeated measures on the same number of elements¹⁰ was used to test the following hypothesis:

There is no significant difference in the mean errors typed by students in the one-minute intervals of a straight-copy five-minute timed test.

The summary of the analysis of variance data is found in Table XII. By using this data, the analysis of variance for repeated measures of errors was computed as shown in Table XIII. The F-ratio for testing the hypothesis was 11.59.

The critical values $F_{.99}(4, 300) = 3.39$ and $F_{.95}(4, 300) = 2.40$ are both less than the observed F-ratio. The second hypothesis was therefore rejected. The analysis of variance indicated a significant difference in the means of errors at one-minute intervals.

9. Students who missed two or more tests were not included in Table XI.

10. Winer, op. cit., p. 105

TABLE XI
AVERAGE ERRORS AT ONE-MINUTE INTERVALS
ON FOUR FIVE-MINUTE TIMED WRITINGS

Student	One-Minute Intervals				
Number	1	2	3	4	5
1	3.25	2.75	2.50	3.75	3.50
2	2.25	3.00	2.25	2.75	2.25
3	1.75	2.00	2.75	1.00	0.75
4	2.25	1.25	1.25	1.00	1.75
5	2.00	1.25	1.75	2.00	1.00
6	2.25	1.75	2.25	3.75	3.50
7	2.50	1.25	2.00	4.75	1.75
8	2.75	2.50	3.50	5.75	4.75
9	1.75	0.00	2.25	3.25	1.00
10	2.00	2.50	1.75	3.25	2.50
11	1.00	2.00	2.50	1.50	0.75
12	1.75	1.50	2.25	4.25	3.25
13	2.75	1.75	2.50	5.50	6.75
14	2.75	1.50	2.50	2.00	3.75
15	4.50	4.00	3.25	4.25	4.50
16	1.75	1.50	1.75	1.00	1.00
17	1.25	2.25	3.50	3.00	3.00
18	2.00	2.00	3.00	2.25	2.00
19	1.25	1.25	1.25	2.75	1.50
20	2.75	3.25	2.75	2.50	2.00
21	2.25	2.75	3.00	5.25	4.75
22	4.25	5.00	5.00	6.75	5.50
23	1.00	1.75	1.50	1.75	2.50
24	3.75	4.75	3.00	5.00	4.00
25	2.75	4.00	2.75	4.00	6.00
26	1.50	2.00	2.75	3.50	2.50
27	1.50	1.00	0.50	2.25	1.25
28	2.50	0.75	2.00	2.25	2.50
29	2.75	1.50	2.00	2.50	1.75
30	0.50	0.50	0.50	0.75	0.75
31	3.50	4.25	5.25	5.75	5.25
32	1.00	2.50	1.00	1.50	2.00
33	1.75	2.00	1.00	3.00	2.50
34	1.00	1.75	1.25	0.50	1.50
35	2.25	3.25	2.25	5.25	4.25
36	1.25	3.00	0.75	1.25	1.00
37	3.75	4.75	3.75	4.25	4.50
38	3.75	2.75	4.00	4.25	3.75
39	3.50	3.50	4.25	6.50	6.00
40	2.75	4.25	2.50	2.50	2.25

TABLE XI (Continued)

AVERAGE ERRORS AT ONE-MINUTE INTERVALS
ON FOUR FIVE-MINUTE TIMED WRITINGS

Student Number	One-Minute Intervals				
	1	2	3	4	5
41	2.25	2.75	2.25	3.00	3.50
42	6.75	3.25	3.00	5.75	8.50
43	1.50	2.00	3.25	2.50	1.50
44	1.75	0.50	2.00	2.75	1.50
45	2.50	2.25	2.50	2.75	3.00
46	1.75	0.75	1.75	1.00	1.25
47	2.75	3.25	3.25	4.75	2.75
48	2.25	3.00	2.25	3.50	2.25
49	3.50	5.25	4.50	4.50	6.00
50	1.00	1.75	1.25	1.00	1.50
51	1.50	3.25	1.50	4.25	4.25
52	2.50	3.50	3.00	2.00	2.75
53	2.50	3.50	3.75	5.25	3.50
54	1.00	0.50	1.25	2.00	1.25
55	3.00	3.33	2.67	3.33	2.33
56	1.00	0.67	0.67	1.00	1.00
57	3.00	1.67	1.67	1.33	1.67
58	3.33	2.00	3.00	3.33	2.00
59	1.67	1.00	2.33	2.33	1.67
60	1.67	2.67	1.67	2.00	3.00
61	2.33	1.33	2.33	2.00	2.33
62	0.67	2.00	0.67	1.33	1.67
63	2.00	2.67	2.67	1.00	2.33
64	3.33	0.67	5.33	3.00	1.67
65	0.33	1.67	1.00	0.67	2.67
66	4.33	3.67	4.33	4.33	5.00
67	3.67	2.67	4.67	5.00	5.33
68	2.33	4.67	3.33	4.67	6.00
69	2.00	1.00	0.33	2.67	0.67
70	2.67	3.67	3.33	4.00	3.00
71	3.00	2.33	0.33	1.67	4.00
72	2.33	0.67	1.33	1.67	2.33
73	1.33	0.33	2.33	1.33	1.67
74	1.00	2.00	2.67	0.67	2.67
75	3.00	2.33	2.00	4.67	4.33
76	1.33	0.67	1.33	0.33	1.00
Mean	2.30	2.30	2.39	2.98	2.86

TABLE XII

SUMMARY OF ANALYSIS OF VARIANCE DATA FOR MEAN ERRORS
AT ONE-MINUTE INTERVALS ON FOUR FIVE-MINUTE TIMED WRITINGS

(n = 76 students)

1st Minute Interval	2nd Minute Interval	3rd Minute Interval	4th Minute Interval	5th Minute Interval	
* $T_1 = 174.57$	$T_2 = 174.44$	$T_3 = 181.99$	$T_4 = 226.33$	$T_5 = 217.59$	$G = 974.92$
$\sum X_1^2 = 487.36$	$\sum X_2^2 = 514.22$	$\sum X_3^2 = 536.00$	$\sum X_4^2 = 867.69$	$\sum X_5^2 = 829.92$	$\sum \sum X_j^2 = 3,235.19$
$\frac{T_1^2}{n} = 400.98$	$\frac{T_2^2}{n} = 400.39$	$\frac{T_3^2}{n} = 435.79$	$\frac{T_4^2}{n} = 674.02$	$\frac{T_5^2}{n} = 622.97$	$\frac{\sum T_j^2}{n} = 2,534.15$
$SS_1 = 86.38$	$SS_2 = 113.83$	$SS_3 = 100.21$	$SS_4 = 193.67$	$SS_5 = 206.95$	$\sum SS_j = 701.04$
$s_1^2 = 1.15$	$s_2^2 = 1.52$	$s_3^2 = 1.34$	$s_4^2 = 2.58$	$s_5^2 = 2.75$	
$\bar{T}_1 = 2.30$	$\bar{T}_2 = 2.30$	$\bar{T}_3 = 2.39$	$\bar{T}_4 = 2.98$	$\bar{T}_5 = 2.86$	

$$(1) G^2/kn = 2501.23 \quad (2) \sum \sum X_j^2 = 3235.19 \quad (3) \sum T_j^2/n = 2534.15 \quad (4) \sum P^2/k = 2989.71$$

* T = Total score in any one minute interval.

TABLE XIII
ANALYSIS OF VARIANCE FOR MEAN ERRORS AT ONE-MINUTE INTERVALS
ON FOUR FIVE-MINUTE TIMED WRITINGS

Source of Variation	Sums of Squares	df	Mean Squares	F
Between People	488.48	75		
Within Person	245.48	304		
Tests	32.92	4	8.23	11.59*
Residual	212.56	300	0.71	
Total	733.96	379		

$$*F_{.99}(4, 300) = 3.39$$

$$*F_{.95}(4, 300) = 2.40$$

Tests on Differences in Errors BetweenPairs of Means

The Newman-Keuls tests¹¹ on differences between pairs of means were computed and summarized in Table XIV. The results of the tests show that the error means typed by students in the fourth and fifth one-minute intervals were significantly higher than those of the first, second, and third intervals.

11. Ibid., p. 114

TABLE XIV

TESTS ON DIFFERENCES BETWEEN PAIRS OF ERROR MEANS AT ONE-MINUTE
INTERVALS ON FOUR FIVE-MINUTE TIMED WRITINGS

(n = 76 students)

Interval		2	1	3	5	4
	Totals	174.44	174.57	181.99	217.59	266.33
2	174.44	----	0.13	7.55	43.15*	51.89*
1	174.57		----	7.42	43.02*	51.76*
3	181.99			----	35.60*	44.34*
5	217.59				----	8.74
4	226.33					----
$q_{.99}(r, 300) = 3.64$				4.12	4.40	4.60
$\sqrt{nMS_{res}} \left[q_{.99}(r, 300) \right] = 26.75$				30.28	32.34	33.81

* Significantly different pairs of means

PART IV

PATTERN OF SPEED AND ERRORS

The findings of this study make it possible to represent graphically the pattern of speed performance and the pattern of accuracy performance of the group.

Pattern of Mean Gross Speed

The graph in Figure 5 was obtained by plotting the mean gross speed at one-minute intervals against time in minutes. The graph shows that the average gross speed for the group dropped significantly in the second minute interval. The recovery of speed was gradual in the remaining intervals until approximately one-half of lost speed was regained.

Pattern of Cumulative Mean Gross Speed

To compute the cumulative gross speed for any one-minute interval, the average gross speed for each interval in the accumulation was added and divided by the number of intervals in each accumulation. This procedure yielded the following cumulative gross speeds for the five consecutive one-minute intervals: 35.2, 34.0, 33.7, 33.6, and 33.7.

Figure 6 shows graphically gross speed accumulated by the group at the end of each one-minute interval. The graph shows the cumulative mean gross speed performance was best within the first

FIGURE 5

MEAN GROSS SPEED AT ONE-MINUTE INTERVALS
ON FOUR FIVE-MINUTE TIMED WRITINGS

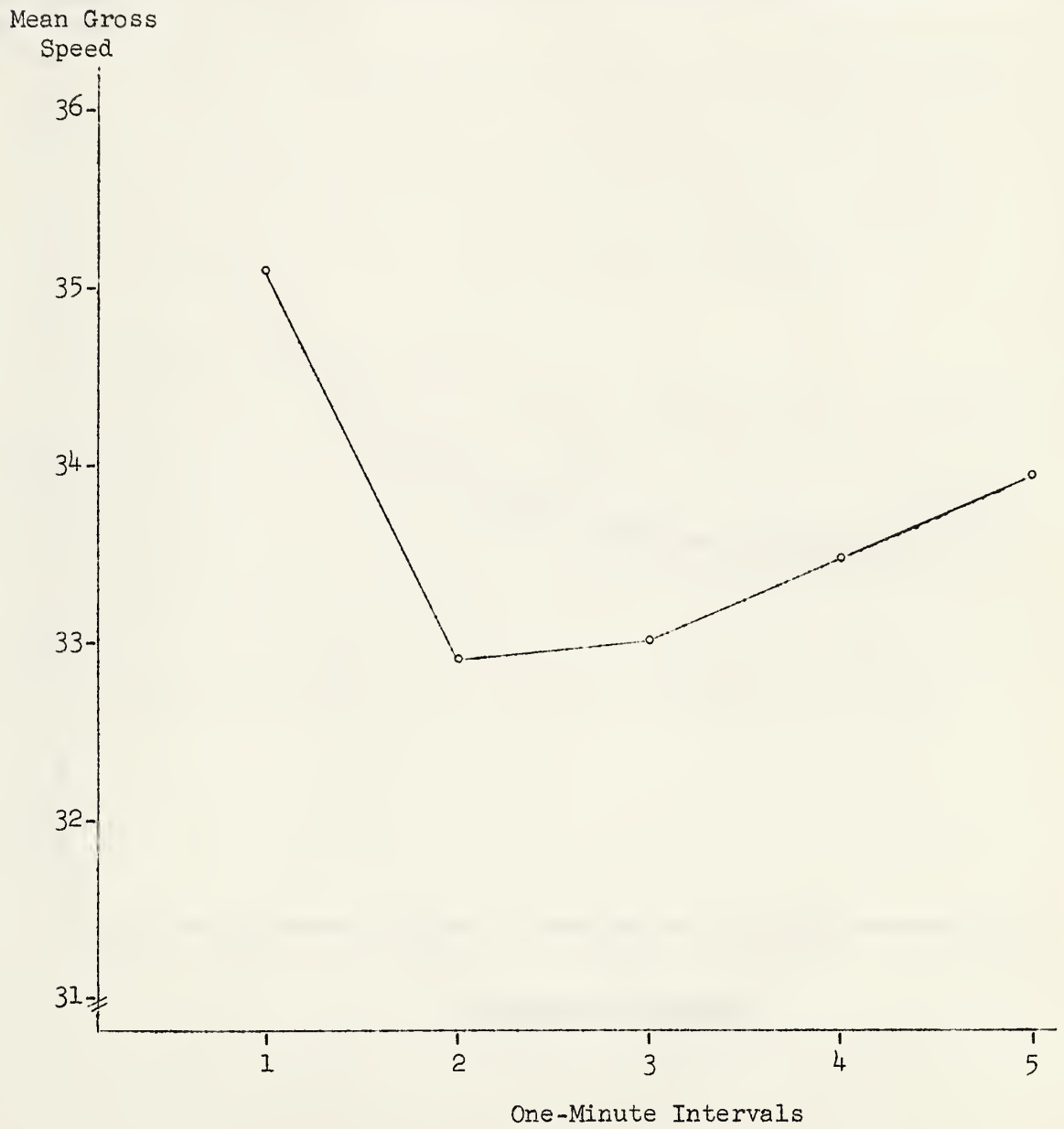
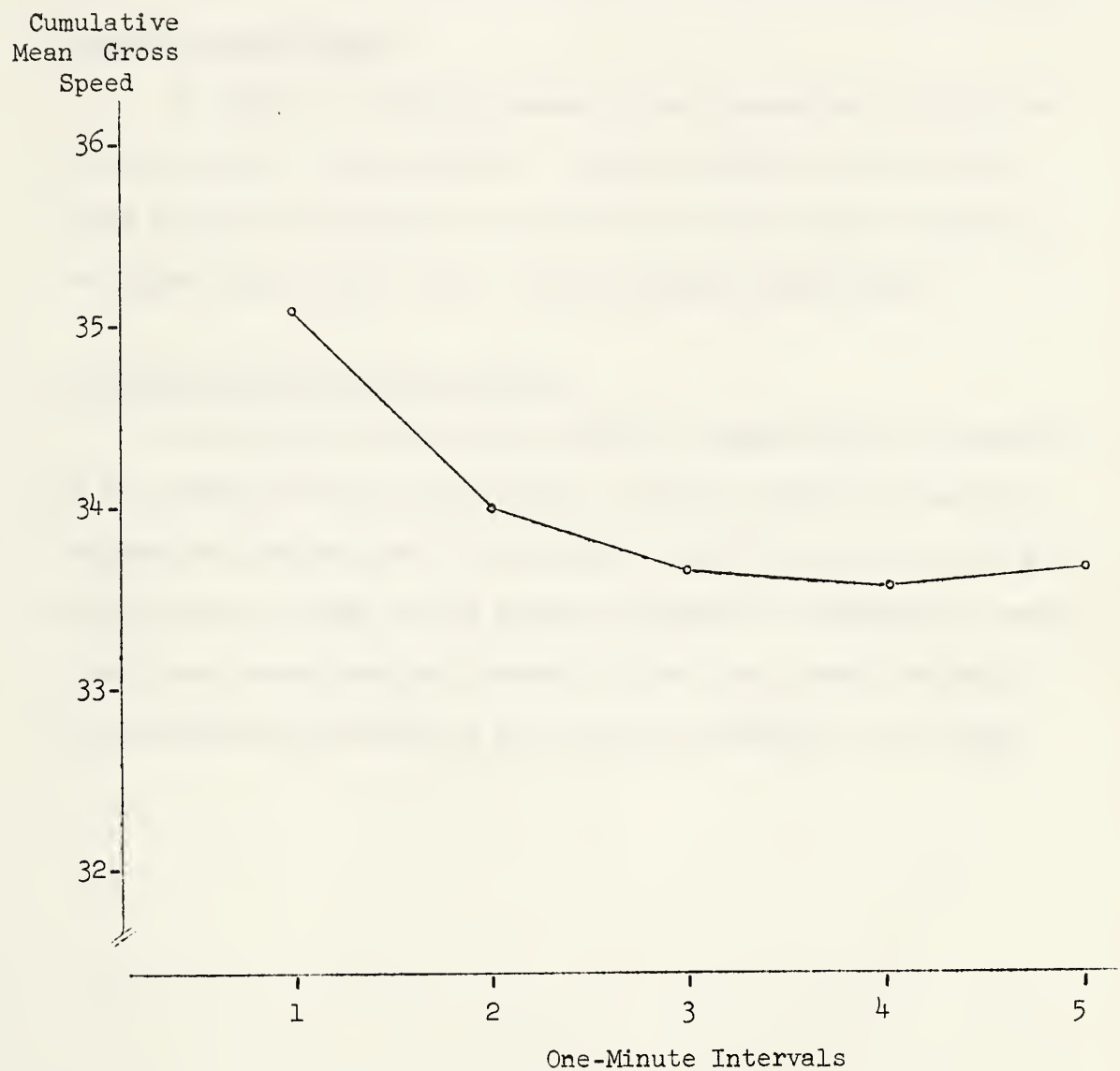


FIGURE 6
CUMULATIVE MEAN GROSS SPEED AT ONE-MINUTE INTERVALS
ON FOUR FIVE-MINUTE TIMED WRITINGS



three intervals. After three minutes of typing, the cumulative gross speed remained nearly constant.

Pattern of Mean Errors

In Figure 7, the error means in each one-minute interval are plotted against time in minutes. The graph shows that the error means remained relatively the same for the first three intervals of the timed tests, after which, they increased significantly.

Pattern of Cumulative Mean Errors

The cumulative mean error rate was computed much the same way as the cumulative mean gross speed. The error rates for the five consecutive intervals were as follows: 2.3, 2.3, 2.3, 2.5, and 2.6. These rates are shown on the graph in Figure 8. Although the accumulated error rates remained constant in the first three intervals, they increased noticeably in the last two intervals of the tests.

FIGURE 7

MEAN ERROR RATES AT ONE-MINUTE INTERVALS
ON FOUR FIVE-MINUTE TIMED WRITINGS

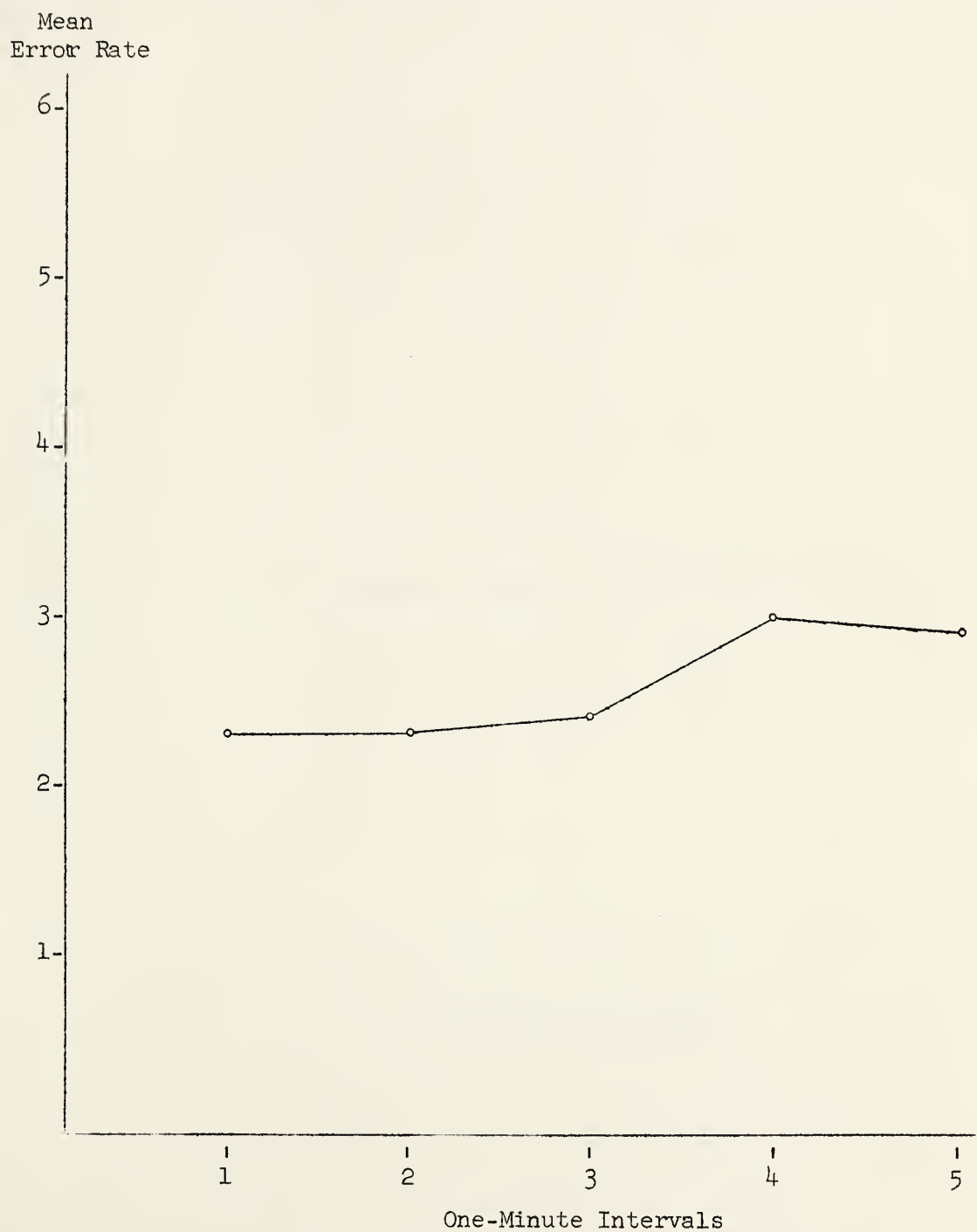
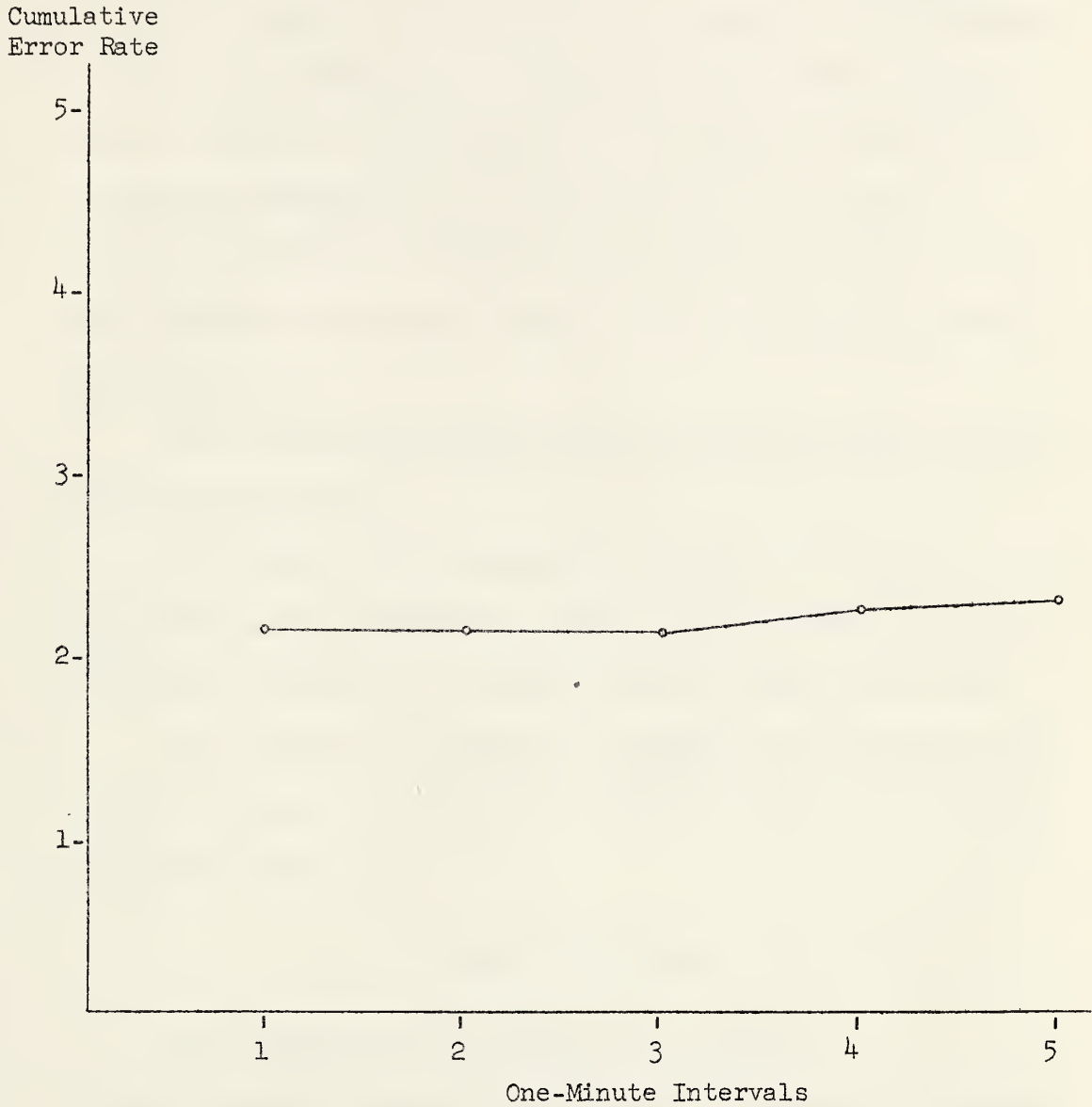


FIGURE 8
CUMULATIVE ERROR RATES AT ONE-MINUTE INTERVALS
ON FOUR FIVE-MINUTE TIMED WRITINGS



CHAPTER V

FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of the study was to determine: (1) the pattern of gross speed performance as indicated by the number of words typed by students in each consecutive one-minute interval of the five-minute straight-copy timed test, and (2) the pattern of accuracy performance as indicated by the number of errors made in each consecutive one-minute interval of the five-minute straight-copy timed test.

The analysis of variance was the technique used to test the following hypotheses:

(1) There is no significant difference in the mean typewriting speed achieved by students of Typewriting 10 in the one-minute intervals of a straight-copy five-minute timed test.

(2) There is no significant difference in the mean errors typed by students in the one-minute intervals of a straight-copy five-minute timed test.

SUMMARY OF FINDINGS

The findings of this study were as follows:

1. The mean gross speeds of the students at consecutive one-minute intervals were: 35.17, 32.80, 33.00, 33.51, and 33.92 words per minute. An examination of these speed figures shows that

the largest gross speed decrease (2.37 words per minute) occurred in the second interval of the timed writings.

2. The first hypothesis that there is no significant difference in the mean typewriting speed achieved by students in the one-minute intervals of a straight-copy timed test was rejected because the analysis of variance indicated that the means of the gross speeds at one-minute intervals were significantly different.
3. The tests on differences between pairs of means indicated that the gross speed in the first interval was significantly higher than any of the gross speeds in the remaining four intervals of the timed writings. The mean gross speed in the fifth interval was significantly higher than the means in the second or third intervals.

The average gross speed in the first interval was higher than the average gross speed in the subsequent intervals in three of the four timed writings.

4. Over the four timed writings, students' cumulative speeds at the end of each consecutive interval were: 35.2, 34.0, 33.7, 33.6, and 33.7 words per minute.
5. The mean errors typed by the students in each consecutive one-minute interval were: 2.30, 2.30, 2.39, 2.98, and 2.86.
6. The second hypothesis that there is no significant difference in the mean errors typed by students in the one-minute intervals of a straight-copy timed test was rejected because the analysis

of variance revealed that the means of the errors at one-minute intervals were significantly different.

7. The tests on differences between pairs of means showed that the mean errors in the fourth and fifth intervals were significantly higher than the mean errors in the first, second, and third intervals.
8. Over the four timed writings, students' cumulative error rates at the end of each consecutive interval were: 2.3, 2.3, 2.3, 2.5, and 2.6.

CONCLUSIONS AND IMPLICATIONS

The conclusions and implications which arise from this study of the typewriting performance of students enrolled in Fort Saskatchewan High School during 1963-64 are as follows:

1. Students' optimum performance in speed and accuracy occurs in the first, second, and third intervals of the five-minute straight-copy timed writings. After three minutes of typing, the cumulative gross speed stabilizes and the cumulative error rate increases noticeably. Although cumulative errors remain constant within the first three minutes of typing, the cumulative gross speed decreases during the same intervals. The implication might be that teacher's expectations of students' performance in speed and accuracy should be based on the length of the timed writings. Because neither the speed nor the accuracy is uniform

throughout the five-minute timed writing, implies that a five-minute test is not equal to a one-minute test repeated five times.

2. The increase in cumulative errors after three minutes of typing suggests the existence of some condition, either physical or psychological, which adversely affects the accuracy performance of students.

RECOMMENDATIONS

The following recommendations are suggested for further study:

1. A similar study should investigate students' gross speed performance and accuracy performance at one-minute intervals on straight-copy timed writings in Typewriting 20 and Typewriting 30.
2. Patterns of speed performance and accuracy performance should be investigated for timed writings of 10 and 15 minutes duration.
3. The present study should be replicated to include schools with larger enrollment in typewriting.
4. Students' reasons for the fluctuation in speed and accuracy should be investigated.
5. A study should be conducted to seek explanation for the pronounced decrease in the average gross speed in the second one-minute interval of the timed writings.
6. Attempts should be made to discover why errors increase in the fourth and fifth intervals of the five-minute timed writings.

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APPENDIX A

COPY OF THE LETTER FROM SOUTH-WESTERN PUBLISHING CO.

COPY OF THE LETTER FROM SOUTH-WESTERN PUBLISHING CO.

June 3, 1964
Cincinnati, Ohio

Mr. Philip Uniat
High School
Fort Saskatchewan, Alberta, Canada

Dear Mr. Uniat

Our Canadian agent, W. J. Gage Limited, has communicated to us your concern about the use of Typewriting Tests 5, 6, 7, and 8 that we publish for 20TH CENTURY TYPEWRITING.

Your use of this material in the testing program that you conducted for the purpose of obtaining information to be used in your thesis has our approval.

We are happy to be able to cooperate with you in this small way. It is our contribution to the advancement of professional business education.

Sincerely yours,

Walter A. Kumpf
Editor in Chief

mvh

APPENDIX B

INSTRUCTIONS READ TO THE CLASS BEFORE EACH TIMED WRITING
AND
CHECK LIST FOR ADMINISTRATION OF TIMED WRITINGS

DIRECTIONS FOR TESTS

The following instructions were read to the class before each test:

- (1) Please type your name at the top of the paper.
- (2) Check for the following on your typewriter:
 - (a) Is the lateral guide in place?
 - (b) Is the line spacer at 2?
 - (c) Are the marginal sets in the proper place for a 50-stroke line?
 - (d) Is the machine set for a 5-space paragraph indention?
- (3) You may return the carriage when you come to the end of a line on the test. That is, you do not have to listen for the bell to return the carriage.
- (4) Adjust the position of the markers so that the pointer reaches the paper when I press the control switch.
- (5) I will now close the switch and you watch to see if the point of the marker reaches the paper. If it does not, please adjust the marker closer to the paper.
- (6) Are there any questions before you begin? Let us have your best performance in both speed and accuracy.
- (7) You may now BEGIN.

CHECK LIST FOR ADMINISTRATION OF TIMED WRITINGS
TYPEWRITING 10 - CLASS A

Student Number	Timed Writing Taken On			
	Mon.	Tues.	Wed.	Thurs.
1	4	2	1	3
2	2	4	3	1
3	2	4	3	1
4	1	4	3	2
5	2	1	4	3
6	4	1	2	3
7	1	4	3	2
8	3	2	4	1
9	1	4	2	3
10	2	3	4	1
11	1	4	2	3
12	1	4	3	2
13	3	2	4	1
14	2	4	1	3
15	3	4	2	1
16	4	3	1	2
17	1	4	3	2
18	4	2	3	1
19	1	2	4	3
20	3	4	1	2
21	3	1	4	2
22	2	1	3	4
23	2	3	1	4
24	4	1	2	3
25	2	1	3	4
26	2	3	4	1
27	2	1	4	3
28	4	2	3	1
29	4	3	1	2
30	2	1	3	4
31	4	1	3	2

TYPEWRITING 10 - CLASS B

Student Number	Timed Writing Taken On			
	Mon.	Tues.	Wed.	Thurs.
32	1	3	2	4
33	1	3	4	2
34	1	3	2	4
35	2	1	4	3
36	3	2	4	1
37	3	1	2	4
38	2	4	3	1
39	1	3	2	4
40	3	1	4	2
41	1	3	4	2
42	2	4	3	1
43	1	2	4	3
44	4	2	1	3
45	3	2	1	4
46	4	2	1	3
47	4	3	2	1
48	2	4	1	3
49	4	1	2	3
50	1	3	2	4
51	3	2	1	4
52	3	4	2	1
53	3	1	4	2
54	2	1	3	4
55	4	1	3	2
56	3	1	4	2
57	2	1	4	3
58	2	3	1	4
59	4	1	3	2
60	1	2	3	4
61	3	1	2	4
62	4	2	3	1

CHECK LIST FOR ADMINISTRATION OF TIMED WRITINGS
TYPEWRITING 10 - CLASS C

Student Number	Timed Writing Taken On			
	Mon.	Tues.	Wed.	Thurs.
63	3	1	4	2
64	3	1	4	2
65	3	2	1	4
66	2	4	3	1
67	1	2	3	4
68	4	1	2	3
69	3	4	2	1
70	1	3	4	2
71	2	4	3	1
72	2	1	4	3
73	1	3	2	4
74	4	2	1	3
75	1	2	4	3
76	3	2	4	1
77	1	2	4	3
78	1	4	3	2
79	2	1	3	4
80	1	3	2	4
81	3	1	4	2
82	1	4	3	2
83	2	1	4	3
84	4	2	1	3

APPENDIX C

TIMED WRITING GIVEN TO ACQUAINT STUDENTS HOW TO ADJUST MARKERS
AND CORRESPONDING WARMUP PARAGRAPH

The error into which most of us fall is in thinking that we will get a new lease on life whenever we decide to do so. We coast along, telling ourselves that, when our big chance comes along, one worth an effort, we will then stretch and make good. There is no mistake that is worse than this. Once you get the habit of coasting, it's too bad for you. The habit gets you and keeps you coasting; and there's only one direction you can coast. To build muscles, you have to use them.

Ambition is seldom wholly dead in any of us; most of us long for the good things that are out of our reach at the moment. But the way to get them is not to give up and let go; rather, it's to take a leaf from the story of the old warrior whose son complained that his spear was too short. The boy's father said, "Then step closer to the foe."

All this is worth talking about because you will soon be in your first position; and the work in any first position is usually so easy for you, since no one expects much of you as a beginner, that you can get the idea that you can relax on the job and stop growing. If that happens, you start coasting, which takes you back down the hills that you climbed to get where you are. If your work is easy, then that is the time to push, and push hard while the pushing is easy. Don't let yourself coast nor stand still; get your muscles ready for the climb. (START OVER)

WARMUP PARAGRAPH

There is one big hazard about which most new workers frequently must be cautioned--that is the danger that the new worker will not know what the old members of the company already have tried and rejected. Trying to tell experienced workers how they should perform duties is not included in the quota of natural errors in judgment that we allow each of the new members of the firm. Each of the new employees must reach par before he can coach.

APPENDIX D

TIMED WRITINGS 1, 2, 3, AND 4

The use of the correct practice levels will assist you in building good typing skill. It is important that you master when and how to use each practice level to profit more and more from your daily practice. This is the way in which to gain most in typing skill.

When the purpose of the practice is to force you into a new level of speed, type on the exploration level and take the brakes of your fingers. Push ahead. The few extra mistakes you make when you force your speed are merely a signal to devote more attention to the correct way to type to reach the goal you desire.

When the purpose of the practice is to obtain results with a high level of accuracy and at the right rate, type on the control level of practice. To typewrite on this level, reduce the speed four to eight words less than your exploration plane so you can type in comfort. Do not attempt to typewrite fast; just keep on typing without fretting as to how well you are doing or how rapidly you are stroking the keys.

Speed comes through steady and sure stroking. Control comes from the use of right technique in handling the typewriter and through the right mind set. Expect improved work of yourself; then do not accept less than your best performance. Your best typing is done with ease and certainty. Pace yourself at such a typing rate. (START OVER)

The men who hire typists for office jobs have said that there are four basic knowledges and skills that they expect from their new office workers. The basics are discussed briefly for you here.

A typist must have a high degree of basic typing skill. This does not apply to straight copy only, but on problem copy as well. He cannot be sluggish and plodding; on the other hand, he need not be lightning fast. He must be able always to set up and type a wide range of typing problems with a minimum of wasted time, motion, and effort.

A typist must have a good command of English grammar. Although much of his daily work will be from copy of one kind or another, there will be many times when he will be required to compose at the machine. In these cases, a good command of the correct way to say things will be most useful. Further each worker in an office is expected to know grammar well enough to catch routine errors made by others in a day's work.

A typist must know the rules of punctuation and how to apply them. The story has been related of how a single misplaced comma cost a firm thousands of dollars in lost sales. Although this account is the exception rather than the rule, the typist must know how to apply the rules so that meaning of each word, figure, and sentence is clear. (START OVER)

It is far better for you to select the position in which you desire to work than merely to accept any sort of position that is first offered to you. It is true, though, that you cannot select a career unless you first make an analysis not only of yourself but the diverse types of positions as well that are open to you.

Your first approach should be to analyze your own knowledges, skills, and traits to arrive at a job which conforms to the qualities you have. You must find out if you are of a mechanical turn of mind. If you prefer to study, you must learn whether you are good at figures or if details cause you trouble. You must decide, too, whether you like to work by yourself or if you prefer to follow the advice of someone else.

Each of these factors and many more should be thought of seriously before you set your mind on your life work. Unless you have the knowledges, skills, and traits required for a certain type of work, you will not be content while working at it. Then again, if you are well qualified for a certain variety of job, and if you get such a job, you will be happy in your work, contented with your lot, and likely to gain promotions. (START OVER)

TIMED WRITING 4

When the telephone rings, answer it at once. The person on the other end may not realize that you are there and may hang up before you finally decide to take the receiver in your hand. When you call someone, give him time to reach the telephone.

As you pick up the receiver, drop every unpleasant mood. If the working day has been a trying one during which everything went wrong, put the upsetting thoughts out of your mind before answering the telephone. When speaking, put all the charm you possess into your voice. The cold, below-zero voice has no place in any phone conversation. Make your voice sound warm and courteous.

Do not forget to address the person you are speaking to by name. Like all other men and women, he likes to hear his own name. If your superior is not in his office at the moment, take the memo pad and write down the name and telephone number of the caller. Ask the caller if he wishes to leave a message. After making the memo, check with the caller to be sure that you have noted the message correctly.

The friends you make by telephone are very important to you in the business world. Your voice represents your company in the minds of all those who deal with it. (START OVER)

APPENDIX E

WARMUP PARAGRAPHS FOR THE TIMED WRITINGS

WARMUP FOR TIMED WRITING 1

Speed and control are your two most important goals when you are learning to type. One without the other is of little or no value. The men who hire office workers want typists who can turn out a day's work for a day's pay, and they want that work to be usable without having to be done over or corrected further. To put it another way, you must be able to type at a high speed with reasonable control.

WARMUP FOR TIMED WRITING 2

Men who hire typists for office jobs say that workers often do not know just what will be expected of them when they go to work in an office. Too many of them seem to think that a typing speed of fifty or sixty words a minute on straight copy is all they need to be successful. What men in business expect of their typists will be discussed briefly for you in the timed writing you are about to take.

WARMUP FOR TIMED WRITING 3

A misfit in an office is never a success. He does not do the best work of which he is capable; he quickly loses interest; and he does not work so that he will deserve advancement. But one who is trained for his work, happy in his particular job, and fitted to progress with his company has the prospect of achieving success in his field.

WARMUP FOR TIMED WRITING 4

The telephone is magic. It is the magic means by which we can talk with others at a distance. The magic of the telephone ranges all the way from its use in bringing our friends within the sound of our voice to its use in selling, for thousands of dollars, the most intricate machine for use in a large factory.

APPENDIX F

TABLE A

AVERAGE GROSS SPEED SCORES ON FOUR FIVE-MINUTE
STRAIGHT-COPY TIMED WRITINGS

TABLE B

AVERAGE NUMBER OF ERRORS ON FOUR FIVE-MINUTE
STRAIGHT-COPY TIMED WRITINGS

TABLE A

GROSS SPEED SCORES ON FOUR FIVE-MINUTE
STRAIGHT-COPY TIMED WRITINGS

Student Number	Timed		Writing	
	1	2	3	4
1	48.6	48.6	49.4	42.8
2	25.0	21.0	24.6	22.4
3	23.2	21.2	24.0	22.4
4	24.4	31.6	31.0	27.4
5	32.2	31.6	32.8	34.4
6	39.0	37.0	39.0	35.2
7	39.0	35.8	37.2	36.4
8	42.2	46.2	46.6	42.2
9	38.0	34.6	34.0	36.4
10	32.6	33.8	32.4	31.6
11	32.4	33.0	36.8	27.8
12	27.4	28.4	25.2	23.8
13	38.4	36.0	37.4	36.2
14	27.2	23.8	26.0	21.8
15	34.0	32.6	33.2	32.0
16	24.6	22.4	23.6	22.6
17	34.6	35.2	33.6	30.0
18	39.2	42.4	34.8	37.6
19	30.8	28.6	31.6	30.4
20	22.0	19.6	23.0	23.2
21	34.0	34.0	35.0	29.8
22	45.4	42.8	42.0	38.4
23	33.8	32.0	36.2	34.4
24	28.2	26.6	26.8	24.8
25	39.6	40.0	36.6	38.2
26	39.6	35.2	34.8	35.4
27	30.4	30.8	37.6	33.6
28	31.2	30.8	30.0	35.2
29	26.2	25.6	27.2	26.2
30	28.2	26.0	26.4	24.2
31	44.8	42.6	44.8	41.0
32	36.4	40.0	43.2	38.2
33	28.2	28.8	27.6	27.6
34	28.4	26.0	26.8	27.2
35	32.8	30.6	31.8	30.8
36	27.4	25.6	26.6	22.8
37	39.2	38.4	39.0	38.0
38	25.6	25.2	26.2	25.0
39	39.6	38.0	41.0	39.4
40	52.8	52.2	53.8	50.0

TABLE A (Continued)

GROSS SPEED SCORES ON FOUR FIVE-MINUTE
STRAIGHT-COPY TIMED WRITINGS

Student Number	Timed Writing			
	1	2	3	4
41	30.2	30.4	27.4	27.4
42	32.0	33.2	29.8	32.0
43	42.8	41.8	43.4	41.0
44	22.0	21.6	21.0	21.0
45	41.0	41.0	44.4	38.6
46	25.0	25.2	23.0	23.2
47	39.8	36.2	35.0	34.8
48	44.4	45.4	45.0	46.8
49	39.2	41.6	42.6	40.8
50	34.0	31.6	33.4	33.4
51	33.6	33.2	35.4	31.4
52	32.8	30.2	28.2	26.4
53	43.8	46.8	49.2	45.8
54	25.4	27.6	26.8	23.8
55	30.6	27.4	29.8	28.0
56	32.0	27.0	29.8	---
57	37.4	36.6	35.0	---
58	32.0	31.4	---	30.6
59	24.6	23.2	23.2	---
60	45.6	43.4	47.2	41.0
61	47.8	---	45.8	43.4
62	---	38.4	40.6	37.2
63	29.4	---	29.6	29.6
64	37.8	37.6	39.6	36.6
65	26.0	24.6	25.2	25.0
66	31.8	28.0	29.6	---
67	42.0	46.6	---	40.6
68	28.6	30.6	31.6	32.0
69	48.8	52.4	49.8	50.6
70	38.2	34.2	35.0	34.4
71	46.2	47.8	48.2	47.4
72	32.4	32.2	32.2	31.2
73	30.8	25.0	29.0	28.4
74	27.8	26.0	26.4	---
75	35.4	38.6	38.6	37.4
76	28.2	26.8	---	25.8
77	25.0	19.4	22.6	---
78	32.2	29.6	32.0	28.8
Mean	34.1	33.3	33.9	32.9

TABLE B

AVERAGE NUMBER OF ERRORS ON FOUR FIVE-MINUTE
STRAIGHT-COPY TIMED WRITINGS

Student Number	Timed Writing			
	1	2	3	4
1	3.8	2.0	4.0	2.8
2	3.6	3.0	2.0	1.4
3	1.2	2.0	1.4	2.0
4	2.0	2.0	0.8	1.2
5	2.2	2.0	1.4	0.8
6	1.8	3.0	3.8	2.2
7	2.6	2.2	2.0	3.0
8	3.2	2.2	7.6	2.4
9	2.2	1.0	1.8	1.6
10	3.2	2.6	2.4	1.4
11	0.8	1.4	2.4	1.6
12	2.8	2.2	1.8	3.6
13	3.8	2.2	3.2	6.2
14	3.0	2.0	3.6	1.4
15	3.2	3.8	3.8	5.6
16	1.2	1.0	1.6	1.8
17	1.6	2.6	2.4	3.8
18	2.0	2.0	3.0	2.0
19	1.2	1.2	2.0	2.0
20	3.0	2.8	2.6	2.2
21	5.2	2.8	4.0	2.4
22	4.0	3.6	6.2	7.4
23	2.6	0.8	1.6	1.8
24	3.6	4.4	4.2	4.2
25	3.0	4.4	4.8	3.4
26	3.4	2.2	1.8	2.4
27	1.4	1.2	1.6	1.0
28	2.4	1.8	1.8	2.0
29	2.2	2.8	2.0	1.4
30	0.0	0.8	1.0	0.6
31	5.2	4.4	6.2	3.4
32	1.4	1.0	1.8	2.2
33	1.6	1.6	2.4	2.6
34	0.8	1.2	0.8	2.0
35	3.4	3.4	3.8	3.2
36	1.6	1.4	1.6	1.2
37	3.8	5.4	3.4	4.2
38	2.4	5.8	4.6	2.0
39	5.2	4.6	6.0	3.2
40	1.6	2.2	4.0	3.8

TABLE B (Continued)

AVERAGE NUMBER OF ERRORS ON FOUR FIVE-MINUTE
STRAIGHT-COPY TIMED WRITINGS

Student Number	Timed Writing			
	1	2	3	4
41	3.2	3.8	1.8	2.2
42	4.0	8.4	4.4	5.0
43	2.4	2.2	2.0	2.0
44	1.8	2.0	1.2	1.8
45	2.8	3.0	4.2	0.4
46	0.6	1.8	1.8	1.0
47	4.6	3.4	3.4	2.0
48	1.4	2.0	2.0	5.2
49	3.2	6.4	5.0	4.4
50	2.4	1.4	0.6	0.8
51	3.0	2.0	3.2	3.6
52	2.0	3.6	3.0	2.4
53	4.2	4.4	3.2	3.0
54	1.4	0.4	1.2	1.8
55	1.3	1.8	1.0	0.4
56	1.4	2.8	0.8	-. -
57	1.6	2.0	3.2	-. -
58	1.0	1.4	-. -	1.8
59	1.8	2.0	1.6	-. -
60	4.0	3.2	2.6	3.8
61	5.0	-. -	3.4	4.4
62	-. -	1.4	2.4	1.6
63	1.4	-. -	3.0	2.2
64	3.8	4.0	4.0	4.8
65	1.6	1.2	1.8	1.0
66	1.2	1.2	1.6	-. -
67	2.2	2.6	-. -	3.4
68	4.8	4.6	3.6	4.0
69	3.2	1.6	3.2	3.6
70	1.8	1.8	4.8	2.4
71	1.4	2.2	2.8	2.4
72	2.2	1.2	5.0	2.8
73	1.0	1.4	1.8	1.0
74	3.6	2.0	3.2	-. -
75	1.2	0.8	1.0	0.8
76	1.8	2.2	-. -	0.8
77	2.0	1.8	2.0	-. -
78	2.2	2.0	2.0	1.4
Mean	2.5	2.5	2.7	2.5

APPENDIX G

TABLE C

NUMBER OF WORDS TYPED IN EACH ONE-MINUTE INTERVAL
OF THE FOUR FIVE-MINUTE TIMED WRITINGS

TABLE D

NUMBER OF ERRORS TYPED IN EACH ONE-MINUTE INTERVAL
OF THE FOUR FIVE-MINUTE TIMED WRITINGS

TABLE C
NUMBER OF WORDS TYPED IN EACH ONE-MINUTE INTERVAL
OF FOUR FIVE-MINUTE TIMED WRITINGS

(T1, T2, T3, and T4 represent Timed Writings 1, 2, 3, & 4.)

Student Number	First Interval				Second Interval				Third Interval				Fourth Interval				Fifth Interval			
	Minute Interval				Minute Interval				Minute Interval				Minute Interval				Minute Interval			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
1	49	46	49	48	50	42	48	40	48	56	51	38	45	50	47	44	51	49	52	44
2	29	29	27	25	24	16	26	24	23	13	21	18	23	25	26	24	26	22	23	21
3	26	21	27	28	25	21	25	20	23	18	23	20	20	24	25	22	22	22	20	22
4	17	26	34	33	28	32	33	22	28	33	32	30	25	30	31	28	24	37	25	24
5	33	31	37	37	29	30	29	33	36	34	34	36	31	29	30	32	32	34	34	34
6	36	32	41	38	39	34	40	26	41	40	38	36	41	35	38	42	38	44	38	34
7	39	35	36	39	38	33	36	32	37	40	33	36	42	32	42	36	39	39	39	39
8	41	44	46	42	41	46	43	40	43	45	47	37	47	47	50	48	39	49	47	44
9	40	29	37	39	34	33	30	37	37	37	35	32	39	37	35	40	40	37	33	34
10	32	34	34	34	29	33	33	29	34	32	33	31	34	35	28	29	34	35	34	35
11	35	33	28	34	31	31	28	22	29	34	28	29	32	32	27	22	35	35	23	32
12	27	31	21	32	27	26	22	14	30	25	26	21	28	29	28	27	25	31	29	25
13	40	35	33	36	34	31	41	31	37	37	38	37	38	37	38	39	43	40	37	38
14	28	24	32	26	25	20	29	19	29	27	26	20	30	24	23	20	24	24	20	24
15	32	33	35	33	32	29	31	29	35	29	34	31	37	33	33	32	34	39	33	35
16	23	24	29	26	25	22	24	23	28	22	20	22	26	23	21	21	21	21	24	21
17	38	37	35	19	31	33	36	34	35	37	32	31	36	34	35	34	33	35	30	32
18	37	45	39	46	43	41	32	40	37	44	35	29	37	42	34	36	42	40	34	37
19	31	31	37	34	32	27	30	29	29	26	31	25	30	29	32	27	32	30	28	27
20	22	22	25	25	19	19	24	23	22	20	22	21	23	20	23	23	24	17	21	24
21	34	34	37	32	31	31	31	28	34	32	32	33	36	37	36	26	35	36	39	30
22	48	40	39	43	39	45	45	37	45	43	44	33	49	42	39	41	46	44	43	38
23	34	33	40	36	36	29	35	29	29	33	35	34	38	32	35	36	32	33	36	37
24	29	29	29	28	27	24	31	25	30	28	22	21	27	26	26	27	28	26	26	23
25	31	37	33	36	41	36	34	37	42	41	36	37	43	45	41	34	42	41	39	47
26	35	35	35	38	39	33	38	39	41	36	36	34	51	39	29	33	32	33	36	33

TABLE C (Continued)

NUMBER OF WORDS TYPED IN EACH ONE-MINUTE INTERVAL
OF FOUR FIVE-MINUTE TIMED WRITINGS

Student Number	First Minute Interval				Second Minute Interval				Third Minute Interval				Fourth Minute Interval				Fifth Minute Interval			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
27	29	30	33	37	37	32	38	32	34	25	41	31	22	23	39	33	30	44	37	35
28	34	34	33	36	33	32	29	35	25	30	30	36	34	29	30	35	30	29	28	34
29	29	31	31	28	24	26	28	24	27	24	24	25	25	20	28	26	26	27	25	28
30	26	30	31	29	25	25	30	26	31	25	23	22	31	27	25	23	28	23	23	21
31	49	44	45	43	48	35	41	38	36	46	48	37	44	40	45	42	47	48	45	45
32	43	39	44	41	37	38	44	39	39	38	45	36	37	43	43	35	26	42	40	40
33	27	29	29	29	28	28	25	26	28	28	27	29	30	29	27	27	28	30	30	27
34	33	28	26	31	25	25	27	26	27	27	26	28	30	27	26	25	27	23	29	26
35	33	32	32	37	35	29	33	25	32	30	33	30	35	30	29	28	29	32	32	34
36	29	28	29	27	25	22	25	21	27	27	26	21	28	23	28	24	28	28	25	21
37	38	39	40	41	36	37	35	37	41	38	42	38	40	39	36	36	41	39	42	38
38	37	29	29	28	20	26	26	24	15	22	25	25	27	26	26	23	29	23	25	25
39	39	38	43	43	35	33	41	41	44	42	43	34	40	41	39	36	38	36	39	43
40	54	47	50	51	56	58	52	50	57	57	55	49	48	54	55	54	49	45	57	46
41	29	35	33	32	30	26	30	26	28	31	22	28	31	28	24	23	33	32	28	28
42	32	37	31	36	34	29	32	28	33	31	28	30	30	32	27	31	31	37	31	35
43	48	43	47	39	44	39	41	43	44	38	41	35	40	47	42	45	38	42	46	43
44	27	26	24	22	23	21	22	22	20	21	20	20	19	19	19	20	21	21	20	21
45	45	39	46	40	42	39	39	34	40	39	45	37	37	46	46	38	41	42	46	44
46	24	26	26	28	25	23	24	23	23	23	21	21	26	29	26	22	27	25	18	22
47	42	34	39	38	36	37	35	34	42	37	39	34	40	36	29	33	39	37	33	35
48	46	45	47	47	43	43	44	45	47	45	47	46	46	52	34	52	40	42	42	44
49	41	40	48	40	40	38	34	37	42	44	41	38	36	46	42	42	37	40	48	47
50	40	33	39	38	33	29	33	34	32	28	30	34	36	30	32	28	28	38	33	33
51	35	35	34	33	29	31	32	26	33	33	35	33	38	34	39	33	33	33	37	32
52	33	33	32	30	32	28	31	27	32	29	18	23	34	29	28	26	33	32	32	26

TABLE C (Continued)

NUMBER OF WORDS TYPED IN EACH ONE-MINUTE INTERVAL
OF THE FOUR FIVE-MINUTE TIMED WRITINGS

Student Number	First Minute Interval				Second Minute Interval				Third Minute Interval				Fourth Minute Interval				Fifth Minute Interval			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
	46	45	50	47	46	52	43	45	39	42	51	46	42	47	50	44	46	48	52	47
53	25	29	30	28	28	24	27	28	28	26	24	22	21	27	28	23	25	31	25	18
54	29	29	29	--	26	25	29	--	29	27	26	--	26	29	23	--	29	20	25	--*
55	--	38	40	39	--	34	51	33	--	40	32	36	--	40	36	41	--	41	34	39
56	31	31	--	32	35	26	--	25	31	30	--	29	35	30	--	27	29	31	--	31
57	41	45	--	46	46	43	--	38	43	46	--	42	37	50	--	34	43	49	--	43
58	--	38	44	40	--	36	38	39	--	40	42	33	--	41	42	39	--	37	40	35
59	32	--	35	33	31	--	28	28	26	--	26	27	28	--	28	27	30	--	31	33
60	37	33	--	36	32	27	--	31	27	34	--	29	33	32	--	29	33	35	--	31
61	30	--	33	29	31	--	28	28	30	--	26	27	34	--	28	26	29	--	30	32
62	51	46	51	--	44	42	44	--	44	49	48	--	47	52	46	--	45	50	52	--
63	41	28	38	--	38	39	35	--	38	31	34	--	36	36	36	--	38	37	32	--
64	29	27	--	28	25	22	--	25	26	26	--	24	23	24	--	27	27	24	--	21
65	29	32	31	--	33	27	35	--	28	30	26	--	22	29	35	--	31	35	31	--
66	49	--	44	46	48	--	45	45	49	--	49	34	49	--	41	48	44	--	50	44
67	39	38	--	36	37	35	--	37	38	39	--	35	37	37	--	36	38	39	--	39
68	30	29	34	--	42	23	29	--	24	29	29	--	29	28	27	--	34	31	29	--
69	51	--	54	53	47	--	43	47	47	--	49	50	46	--	56	54	53	--	47	49
70	41	38	42	--	50	34	32	--	24	37	32	--	33	34	32	--	39	40	37	--
71	42	21	31	--	28	28	31	--	33	26	31	--	32	26	27	--	25	34	29	--
72	35	34	--	33	33	29	--	30	32	31	--	31	32	28	--	28	28	35	--	31
73	24	23	--	27	25	23	--	25	23	21	--	21	21	24	--	21	30	25	--	22
74	40	39	43	--	48	44	44	--	45	44	51	--	50	46	52	--	45	44	46	--
75	--	26	34	31	--	27	30	27	--	28	25	26	--	27	28	27	--	29	32	29
76	--	26	34	31	--	27	30	27	--	28	25	26	--	27	28	27	--	29	32	29
Mean	35.3	33.7	35.7	35.8	34.2	31.5	33.4	31.6	33.8	33.3	33.1	31.7	34.3	33.8	33.5	32.8	33.9	34.7	33.7	33.5

* Blank spaces in the above table indicate that the student was absent on the day of tests.

TABLE D

NUMBER OF ERRORS TYPED IN EACH ONE-MINUTE INTERVAL
OF THE FOUR FIVE-MINUTE TIMED WRITINGS

(T1, T2, T3, and T4 represent Timed Writings 1, 2, 3, & 4.)

Student Number	First Minute Interval				Second Minute Interval				Third Minute Interval				Fourth Minute Interval				Fifth Minute Interval			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
1	2	1	0	4	3	0	1	4	3	0	1	4	3	0	1	4	5	3	1	2
2	2	6	2	2	2	2	2	2	2	1	1	4	2	1	1	4	2	3	1	2
3	0	4	3	0	1	1	4	4	3	3	3	3	3	3	3	3	1	2	2	2
4	3	0	1	4	4	4	4	4	3	3	3	3	3	3	3	3	5	3	1	1
5	0	1	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
6	1	1	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	2	2	2
7	2	1	1	4	4	4	4	4	3	3	3	3	3	3	3	3	3	2	2	2
8	1	1	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	2	2	2
9	3	1	4	3	3	1	4	2	2	0	1	2	2	0	1	2	2	0	2	2
10	1	0	3	3	3	1	2	3	2	2	2	2	2	2	2	2	2	2	2	2
11	0	3	3	3	3	1	2	3	2	2	2	2	2	2	2	2	2	2	2	2
12	3	1	2	3	1	1	0	3	1	1	1	0	3	1	1	0	3	1	1	1
13	3	3	5	4	0	1	0	6	4	3	3	3	4	2	1	2	4	3	2	6
14	4	0	1	0	0	3	3	4	1	1	2	2	2	2	2	2	3	2	6	7
15	0	1	0	0	5	2	0	4	1	1	2	2	2	2	2	2	4	3	4	11
16	2	1	2	0	2	2	2	2	2	2	2	2	2	2	2	2	4	3	4	2
17	1	2	0	3	3	1	0	3	3	3	3	3	3	3	3	3	1	1	4	5
18	0	0	5	5	3	1	4	1	1	4	1	1	4	1	1	4	1	1	4	1
19	5	3	1	4	1	1	2	2	6	3	4	5	9	4	5	9	2	5	4	2
20	5	3	1	4	1	1	2	2	6	3	4	5	9	4	5	9	2	5	4	2
21	5	3	1	4	1	1	2	2	6	3	4	5	9	4	5	9	2	5	4	2
22	5	3	1	4	1	1	2	2	6	3	4	5	9	4	5	9	2	5	4	2
23	5	3	1	4	1	1	2	2	6	3	4	5	9	4	5	9	2	5	4	2
24	5	3	1	4	1	1	2	2	6	3	4	5	9	4	5	9	2	5	4	2
25	5	3	1	4	1	1	2	2	6	3	4	5	9	4	5	9	2	5	4	2
26	5	3	1	4	1	1	2	2	6	3	4	5	9	4	5	9	2	5	4	2

TABLE D (Continued)

NUMBER OF ERRORS TYPED IN EACH ONE-MINUTE INTERVAL
OF THE FOUR FIVE-MINUTE TIMED WRITINGS

Student Number	First Minute Interval				Second Minute Interval				Third Minute Interval				Fourth Minute Interval				Fifth Minute Interval			
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
27	2	2	2	0	1	1	0	2	1	3	0	1	2	1	3	1	1	2	1	1
28	3	3	1	3	2	0	1	1	3	1	3	2	4	3	3	2	3	1	4	1
29	3	5	4	0	3	3	4	7	0	2	6	0	0	2	0	4	0	2	1	1
30	0	0	1	2	0	2	3	2	7	1	0	2	5	0	9	2	8	2	8	2
31	3	5	1	2	3	2	4	2	1	0	0	2	0	5	2	5	1	2	1	1
32	0	1	4	2	3	2	3	2	0	0	4	0	3	2	2	0	2	3	3	3
33	1	1	1	3	3	4	4	1	1	0	0	4	0	2	2	3	1	2	3	3
34	0	2	0	2	2	3	4	3	3	3	1	4	3	0	6	0	4	0	2	4
35	1	2	2	3	2	3	4	3	1	2	0	4	7	5	2	3	1	2	7	3
36	2	0	3	1	4	4	4	3	3	1	1	3	3	1	6	3	4	0	3	4
37	1	5	5	3	6	4	4	3	3	3	0	2	6	3	1	0	5	6	3	0
38	3	4	4	2	1	3	3	1	3	3	1	4	8	2	4	5	3	6	3	4
39	5	3	3	3	5	1	5	0	5	5	6	6	7	5	10	4	6	6	3	3
40	2	3	2	2	3	2	2	2	2	7	4	2	7	1	2	4	0	7	5	4
41	3	4	1	2	5	4	7	1	1	1	7	4	3	3	3	2	4	5	3	5
42	2	3	6	3	3	5	1	3	3	3	6	6	4	1	2	4	4	2	6	2
43	2	1	6	5	2	3	1	5	2	3	3	2	3	7	7	3	7	1	6	9
44	1	3	1	2	3	2	1	1	1	2	2	3	2	2	3	4	1	2	2	2
45	2	2	2	0	2	2	0	0	5	3	2	2	4	3	1	0	4	1	2	1
46	1	4	2	0	1	3	3	1	2	0	3	4	1	6	5	1	0	2	5	0
47	2	4	6	0	3	4	2	4	6	1	3	6	0	3	2	2	4	3	4	2
48	2	2	3	4	3	3	2	4	1	5	4	3	6	1	2	1	0	2	3	1
49	2	6	1	0	3	3	6	4	3	4	0	5	0	3	7	5	0	8	8	4
50	3	1	3	0	3	2	2	1	1	5	1	3	1	3	2	5	3	2	1	7
51	1	1	1	3	2	4	3	4	4	0	0	0	3	1	4	2	0	3	3	2
52	2	5	3	0	4	3	3	5	2	0	3	2	1	7	1	5	3	4	2	3

TABLE D (Continued)

NUMBER OF ERRORS TYPED IN EACH ONE-MINUTE INTERVAL
OF THE FOUR FIVE-MINUTE TIMED WRITINGS

Student Number	First Minute Interval				Second Minute Interval				Third Minute Interval				Fourth Minute Interval				Fifth Minute Interval			
	T1		T2		T3		T4		T1		T2		T3		T4		T1		T2	
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
53	4	3	1	2	4	3	5	2	5	2	5	3	5	7	3	6	3	4	5	2
54	1	1	0	2	1	0	1	0	2	2	0	2	2	1	3	3	1	0	2	2
55	5	1	3	-	5	3	2	-	2	2	1	-	2	3	2	-	2	2	3	-*
56	-	1	0	2	-	1	1	0	-	3	1	0	0	0	2	1	-	1	1	1
57	2	4	-	3	4	0	-	2	3	2	-	4	2	-	3	4	0	-	-	4
58	4	3	-	3	2	2	-	2	-	2	2	2	3	2	-	3	-	1	4	0
59	-	1	3	1	-	1	0	4	2	4	-	2	2	-	5	1	2	4	4	3
60	2	-	2	4	2	0	3	2	1	2	-	2	1	2	-	1	1	-	-	5
61	1	2	-	4	2	2	-	2	4	4	1	2	2	-	1	1	0	1	3	2
62	1	-	1	0	2	-	2	2	1	3	-	0	1	-	1	1	0	-	-	5
63	2	2	2	-	2	1	5	-	3	3	3	2	2	3	0	-	0	0	5	2
64	5	2	3	-	0	1	1	-	1	3	2	1	1	0	1	-	0	1	4	-
65	1	0	-	0	2	2	-	1	1	1	1	2	1	1	1	-	3	3	-	2
66	8	4	1	0	4	4	3	-	5	7	5	-	3	5	5	-	2	5	8	-
67	5	-	3	3	3	-	2	6	3	3	4	-	6	4	4	4	4	7	4	8
68	3	1	-	3	5	1	-	5	0	0	0	3	3	4	-	-	0	6	-	-
69	1	3	2	-	1	1	1	-	5	3	1	-	2	1	3	6	1	1	6	2
70	2	-	3	3	4	-	2	5	0	0	-	1	-	-	2	-	1	-	5	-
71	2	2	5	-	3	1	3	-	2	0	1	0	3	4	3	-	3	4	2	-
72	2	4	1	-	0	1	0	-	2	2	2	-	0	1	1	-	2	3	-	1
73	0	2	-	2	1	0	-	1	0	4	3	1	-	2	1	1	3	1	-	-
74	1	2	0	-	1	2	-	-	4	1	1	-	3	1	-	-	3	4	1	-
75	5	3	1	-	3	2	3	-	1	1	4	-	1	3	3	-	3	4	6	-
76	-	2	2	0	-	2	0	0	-	1	3	3	1	0	1	0	-	2	1	0
Mean	2.3	2.6	2.4	2.0	2.6	1.9	2.2	2.6	2.7	2.3	2.4	2.3	2.6	3.1	3.3	3.0	2.6	2.7	3.6	2.7

* Blank spaces in the above table indicate that the student was absent on the day of tests.





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